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4600 Prospect Avenue

TRANSACTIONS
of the
American Society for Steel Treating

Vol. 1 Cleveland, July, 1921 No. 10

WHEN WILL INDUSTRY RESUME?

With the slowing down of business during the past nine months, practically every industry in the country has been affected. The tapering off of operations when compared with the relatively high level of the early months of 1920 seems greatly pronounced. As an indication as to the extent of decline in business, the iron and steel industry with its continually falling output of raw materials, especially pig iron and steel ingots, offers excellent data for consideration. For seven consecutive months production figures have continued to decline and from all indications at present will continue to fall, since not one ripple on the surface points to an early revival of trade. Even authorities in economic problems hesitate to base predictions upon analyses of conditions as they exist today.

According to figures compiled monthly by *The Iron Trade Review* production of coke and anthracite pig iron in May reached the lowest point on record since June, 1908, a period of 13 years. This fact alone while significant is greatly magnified when it is stated that the pig iron producing capacity of the United States is far in excess of that of 1908, due to the increased demand for iron during recent years. It is safe to assume that the present manufacture of pig iron is not over 35 per cent of the potential capacity of blast furnaces, based on previous high point years. In October, 1920, pig iron produced was at the rate of 106,075 gross tons per day and was the second highest month of 1920. In May, 1921, the daily rate had fallen to 39,199 tons and represented but 37 per cent of the October figure. Both iron made for sale and iron made for conversion to steel has suffered loss, although the former has been the most seriously affected. Part of the merchant iron loss may be assigned to the almost complete shut down of gray iron foundries, which have supplied the automotive industry with castings.

The country possesses 436 blast furnaces and on Sept. 30, 1920, 317 of these were in production. Month by month the number of stacks has been reduced until on May 31, but 89 were in operation, 228 having been blown out during the eight months. Thus in May, only 28 per cent of the October stacks were in blast and only 20.4 per cent of the total stacks in the country. The 89 furnaces were the lowest number active on record.

Steel ingot production as well as pig iron has undergone a decline since last fall. According to figures compiled by the American Iron and Steel Institute, ingots produced in May were approximately 1,500,000 gross tons. In October, 1920, the output was approximately 3,680,000

gross tons. The present rate of manufacture is 40.5 per cent of that of eight months ago.

Comparison of these figures with declines in previous periods of depression shows that at no time in modern history has curtailment been so drastic or so extended. Thus in this respect conditions differ widely. The question now on every lip is when will the bottom be reached and how rapidly will operations pick up once they are started on the up grade.

ALLOY STEEL OUTPUT FOR 1920 HOLDS UP

Production of alloy steel ingots and castings during 1920 was the second highest on record, according to a report of figures compiled by the American Iron and Steel Institute. The tonnage aggregated 1,660,292 gross tons, a gain of 179,104 tons or 10.8 per cent over the 1919 figure of 1,481,188 tons and but 127,560 tons less than the 1,787,852-ton high record of 1918. Of the 1920 total, 1,591,939 tons were steel ingots and 68,353

FIG. 1—MANUFACTURES BUILDING, STATE FAIR GROUNDS, INDIANAPOLIS, WHERE THIRD ANNUAL EXHIBITION OF THE AMERICAN SOCIETY FOR STEEL TREATING WILL BE HELD, SEPT. 19-24

tons were steel castings. Corresponding figures for previous years were: In 1919, ingots 1,435,816 tons and castings 45,372 tons; in 1918 ingots 1,721,367 tons and castings 66,485 tons.

The 1920 tonnages of alloy ingots were divided according to process as follows: Open-hearth basic 1,116,923; open-hearth acid 129,832; bessemer 81,809; crucible 29,513; and electric and miscellaneous steel 233,862 tons. Corresponding tonnages for 1919 were: Open-hearth basic 1,056,137; open-hearth acid 114,923; bessemer 66,581; crucible 22,600; and electric and miscellaneous 175,575 tons. It is interesting to note that the greatest relative gain was made in the electric and miscellaneous processes, the increase over 1919 being 33 per cent.

REDUCED RATES TO INDIANAPOLIS

We are very glad to announce that the railroads of the country, through the Central Passenger Association, have granted fare and a half round trip for members of the Society and their dependents, for the Indianapolis Convention and Exhibition, Sept. 19 to 24. A large number of members and guests are always in attendance at this Convention, thus the railroads unanimously decided to recognize the Society to the extent of granting the fare and a half for the round trip.

FIG. 2—INTERIOR OF MANUFACTURES BUILDING, SHOWING A PART OF THE 76,000 SQUARE FEET OF FLOOR SPACE TO BE USED BY THE EXHIBITORS

There are certain restrictions placed on the purchase of these tickets inasmuch as an identification certificate must be presented to the ticket agent for the purchase of the round trip ticket. This identification certificate will be mailed to all the members of the Society before the first of September.

The reduction of railroad fares will contribute materially to an increase in attendance and there is no doubt but that the number visiting Indianapolis will be in excess of the 10,000 in attendance at Philadelphia.

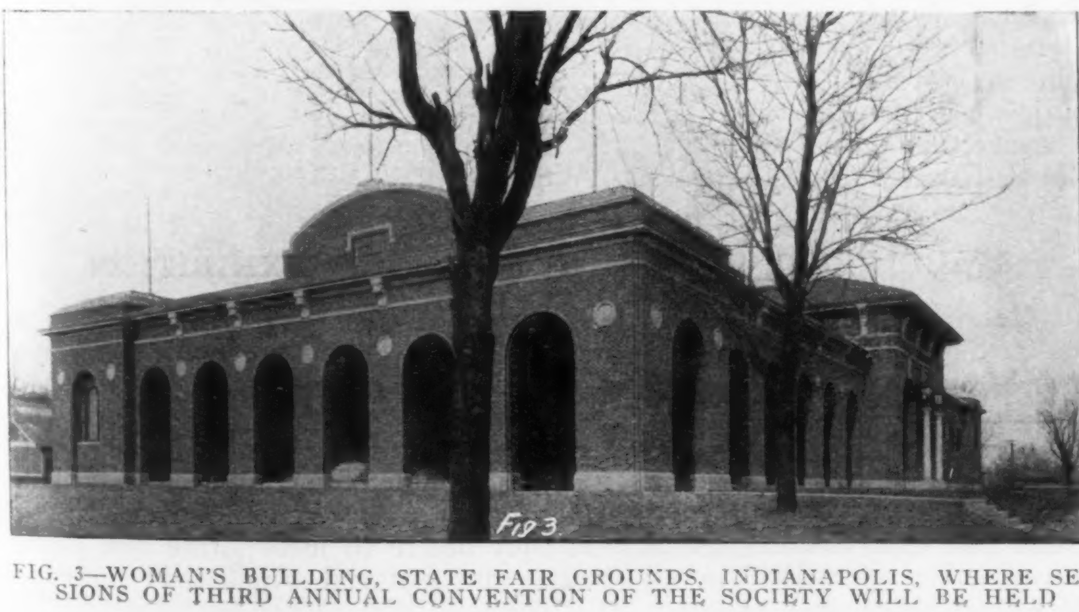

FIG. 3—WOMAN'S BUILDING, STATE FAIR GROUNDS, INDIANAPOLIS, WHERE SESSIONS OF THIRD ANNUAL CONVENTION OF THE SOCIETY WILL BE HELD

HOTELS IN INDIANAPOLIS

Indianapolis has promised to provide our guests with excellent accommodations as far as hotels are concerned, and through the efforts of J. E. Burns Jr., chairman of the Hotel Committee, a list of hotels is given below.

All persons in attendance at Indianapolis will make their own reservations direct with the managers of the hotels, and it is advisable that the members take this precaution. When making reservations give date of arrival, kind of room desired, and price you wish to pay, and what is most important, request the hotel manager to answer your letter repeating the reservation. Then take the letter with you to present to the hotel clerk at Indianapolis when you register.

This precaution taken now may avoid serious difficulty at the time of the Convention.

It is recommended that reservations be made immediately.

The list of hotels follows:

Hotels	Capacity	Rates
Brevort Hotel	94 Rooms	$1.25 to $3.00 per day
New Colonial Hotel	92 "	$2.00 to $4.00 " "
New Denison Hotel	175 "	$1.25 to $2.00 " "
Edward Hotel	150 "	$1.25 to $4.00 " "
Grand Hotel	76 "	$1.50 to $3.00 " "
Hotel Lincoln	100 "	$2.00 up " "
Lorraine Hotel	90 "	$1.00 to $4.50 " "
New Morton Hotel	65 "	$1.50 to $5.00 " "
Great Eastern Hotel	126 "	$1.25 to $3.00 " "
Stubbins Hotel	75 "	$1.00 to $4.50 " "
Hotel Severin	400 "	$2.50 to $8.00 " "
Hotel Washington	300 "	$2.50 to $4.00 " "
Hotel Williams	92 "	$1.75 up " "
Terminal Hotel	45 "	$1.50 up " "
Ohio Hotel	40 "	$1.50 up " "
Claypool Hotel	700 "	$2.50 up " "
Frohman Hotel	80 "	not over $3.50 " "
Haugh Hotel	60 "	" " " " "
Linden Hotel	250 "	" " " " "
Majestic Hotel	59 "	" " " " "
Roosevelt Hotel	187 "	" " " " "
Royal Hotel	85 "	" " " " "

SPACE RESERVED AT INDIANAPOLIS EXHIBITION

Reservations for space at the Convention and Exhibition at Indianapolis, Sept. 19-24, are coming in at such a rate as to bring forth the probability that every available space will be taken when the Convention opens on Sept. 19. The attendance during the coming Convention will be up to, if it does not exceed the expectations of the Board of Directors. Information the board receives from the membership and from manufacturing plants indicates that they are going to take the opportunity to attend this Convention inasmuch as they desire to incorporate and place into effective operation any equipment and material which may increase the efficiency in their plants.

SPACE RESERVED AT INDIANAPOLIS EXHIBITION

The latest list of exhibitors whose products will be on exhibition at the Convention follows:

Selas Co., economic gas appliances in operation	3
Charles Englehard, temperature control and recording instruments in operation	
Smith Gas Engineering Co., producer gas machines in operation.	4
George J. Hagen Co., oil and gas furnaces in operation	7
Westinghouse Elec. & Mfg. Co. electric appliances in operation	8 9
Brown Instrument Co., recording instruments in operation	A-B
Midvale Steel & Ordnance Co., operating exhibit of steels	17
Indianapolis Drop Forging Co., forgings in operation	18
Eaton Electric Furnace Co., electric furnaces in operation	19
Calorizing Co. of Pittsburgh, calorizing process in operation	20
Deeds Commercial Laboratories, carbonizing compounds in operation	21
Leeds & Northrup Co., electric furnaces and pyrometers in operation	22
Bausch & Lomb Optical Co., metallographic instruments in operation	36-23
Tate-Jones Co., Inc., furnaces	24
Armstrong Cork & Insulating Co., insulating materials	25
Taylor Instrument Co., in operation	27
Ludlum Steel Co., steels	28
Marschke Mfg. Co., electric grinders and buffers in operation	43-30
Quigley Furnace Specialties Co., furnace specialties in operation	31
Hoskins Mfg. Co., electric furnaces and recording instruments in operation	32
Simonds Mfg. Co., steels and saws in operation	33
General Electric Co., electric furnaces in operation	34
William Ganschow Co., gears	35
Bristol Co., recording instruments in operation	37
Bethlehem Steel Co., steels	40
Spencer Turbine Co., blowers in operation	57-44
Driver Harris Co., alloy pots and boxes	45
Crucible Steel Co. of America, steels	49
Electric Steel Co. of Indiana, castings	63-51-50
Penton Publishing Co., "The Iron Trade Review"	55
Witherow Steel Co., continuous die forming	58
Halcomb Steel Co., steels	62
Atlas Crucible Steel Co., steels	82-69
Bell & Gossett, case hardening materials	83-70
The Iron Age, publications	74
Deeds & Chapin, "Cinch" cement	75
Case Hardening Service Co., carburizing compounds	81
General Alloys Co., alloy pots and boxes	87
Electrical Refractories Co., refractory materials	107-94
W. S. Rockwell Co., oil and gas furnace	95
Electric Alloy Steel Co., alloy steels	99
Colonial Steel Co., steels	100
Herman A. Holz, Inc., metallurgical equipment	108
Bureau of Standards, research work	119
Imperial Drop Forging Co., forgings	124
Vanadium Alloy Steel Co., steels	120
Heppenstall Knife & Forge Co., die blocks	125
E. C. Atkins Mfg. Co. metal saws and cutting machines	126
Mahr. Mfg. Co., furnaces	153
Dearborn Chemical Co., oils and rust preventatives	Unassigned
Central Steel Co., alloy steel	Unassigned
Celite Products Co., insulating materials in operation	Unassigned
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PROPOSED CHANGES TO THE CONSTITUTION

On May 18, the Constitution and By-Laws Committee, composed of C. E. McQuigg, metallurgist of the Electro-Metallurgical Co.; J. E. Halbing, assistant superintendent of heat treating of the Ingersoll Rand Co.; J. G. Morrow, inspection engineer of the Steel Company of Canada; held a meeting in Syracuse, and proposed the following changes to the Constitution and By-Laws of the American Society for Steel Treating.

According to the present Constitution, these changes were first submitted to the Board of Directors and the changes were approved by a two-thirds vote of the Board.

In addition to publication in the Transactions, a copy of these proposed changes will be sent to all the members, and at the expiration of 60 days a voting ballot will be mailed to members so that they may vote upon the proposed changes.

PROPOSED AMENDMENTS TO THE CONSTITUTION AMERICAN SOCIETY FOR STEEL TREATING

Article V, Section 4

Now reading:

Section 4. A member shall be a person engaged in work relating to the arts and sciences of iron or steel who is twenty-one years of age or over and who is not engaged in the actual solicitation of orders for metals, materials, supplies, equipment, or apparatus of whatsoever nature used in the art, nor any administrative officer ranking in authority over the sales department of any firm engaged in such trades.

To be amended to read as follows:

Section 4. A member shall be a person engaged in work relating to the arts and sciences of iron or steel who is 21 years of age or over and who is not in the Sales Department of any firm dealing in or manufacturing metals, materials, supplies, equipment or any apparatus of whatsoever nature used in the art.

Article V, Section 5

Now reading as follows:

Section 5. An associate shall be a person engaged in work relating to the arts and sciences of iron or steel who is twenty-one years of age or over, and who is engaged in the actual solicitation of orders for metals, materials, supplies, equipment, or apparatus of any nature used in the art, or an administrative officer working in authority over the sales department of any firm engaged in such trades.

To be amended to read:

Section 5. An associate member shall be a person engaged in work relating to the arts and sciences of iron or steel who is 21 years of age or over, and who is in the Sales Department of a firm dealing in or manufacturing metals, materials, supplies, equipment, or apparatus of whatsoever nature used in the art.

Article V, Section 8

Now reading:

Section 8. Honorary members and members are entitled to vote and hold office. Associates, sustaining members and juniors are not entitled to vote or hold office, but are entitled to all other privileges of membership. Honorary members and members are entitled to vote on all questions brought before the membership at any meeting, in person, by mail, or by a proxy given to a person entitled to vote. A proxy shall be given and shall be valid for the decision or vote upon only such matters as shall be indicated on the face thereof, and no proxy shall be valid for a greater length of time than three months.

To be eliminated in its entirety, and sections 8 and 9 as follows, to be substituted:

Section 8. All classes of members except juniors are entitled to vote on all questions brought before the membership at any meeting; in person, by mail or by a proxy given to a person entitled to vote. A proxy shall be given and shall be valid for the decision or vote upon only such matters as shall be indicated on the face thereof, and no proxy shall be valid for a greater length of time than three months.

Section 9. Honorary members, members and sustaining members whose qualifications entitle them to member classification, may hold office. Associates and sustaining members whose qualification place them in the associate classification are entitled to hold office on executive committees of local chapters, except the offices of chairman and vice chairman, and to appointment on National committees. The number so elected or appointed, however, must always be a minority on any given committee.

Article VI, Section 2

Now reading as follows:

Section 2. All applications for admission for membership as members, associate, juniors, or sustaining members shall be accompanied by initiation fee and be presented

to the Executive Committee of the local chapter, which shall consider and act upon each application, assigning each approved applicant to the grade of membership to which, in the judgment of said Executive Committee, his qualifications entitle him. In the absence of a local chapter, application for membership to the Society shall be made to the Board of Directors, which Board shall act in the same manner as said Executive Committee.

To be amended to read:

Section 2. All applications for admission for membership as members, associate members, junior members, or sustaining members, shall be presented, accompanied by initiation fee when such is required, to the executive committee of the local chapter, which shall consider and act upon each application, assigning each approved applicant to the grade of membership to which, in the judgment of said executive committee his qualifications entitle him. In the absence of a local chapter, applications for membership in the Society shall be made to the Board of Directors, which Board shall act in the same manner as said executive committee.*

Article VI, Section 6

Now reading:

Section 6. The initiation fees for membership shall be as follows:

For Member	$ 3.00
For Associate	10.00

To be amended to read:

Section 6. The initiation fees for membership shall be as follows:

For Member	$ 3.00
For Associate Member	3.00
For Sustaining Member	*No fee*
For Junior Member	*No fee*

Article VIII, Section 11

Now reading:

Section 11. The President or any member of the Board of Directors shall not be eligible for immediate re-election to the same office then held, at the expiration of the term for which he was elected.

To be amended to read:

Section 11. The President, or any member of the Board of Directors with the exception of the Secretary and Treasurer, shall not be eligible for immediate re-election to the same office then held, at the expiration of the term for which he was elected.

Article XIV, Section 1

Now reading as follows:

Section 1. Amendments to the Constitution may be effected in the following manner: The Board of Directors may, by affirmative vote of two-thirds of its entire membership, propose amendments, which must be submitted by letter to the voting membership of the Society. Not less than two months following the mailing of such proposed change a ballot shall be mailed to each member, to be returned to the Society's headquarters not later than one month following the date of its issue, and the result of a majority of such ballots returned shall govern.

To be amended to read:

Section 1. Amendments to the constitution may be effected in the following manner: The Board of Directors may, by affirmative vote of two-thirds of its entire membership, propose amendments which must be submitted to the voting membership of the Society. In not less than two months following the notification of such proposed change, a ballot shall be mailed to each voting member to be returned to the Society headquarters not later than one month following the date of its issue, and the result of a majority of such ballots returned shall govern.

PROPERTIES AND MICROSTRUCTURE OF HEAT TREATED NONMAGNETIC, FLAME, ACIDS AND RUST RESISTING STEEL

By Charles M. Johnson*

(A Paper Presented Before Several Chapters of the Society)

The writer has made a study of the steels about to be described covering a period of a year or more, originally with a view to producing a steel that could be forged, rolled or sheared in thicknesses of 0.01 to 1 inch or more and offering a maximum resistance to attack by oxyacetylene flame.

It was also demanded that the steel be machinable and that holes could be drilled in the same. As the results now stand, a steel has been produced that has certain unusual properties which are briefly described in the tabulations that follow.

As to the nonmagnetic features, a permanent horseshoe magnet which is capable of suspending in the air a 500-gram weight, will attract only the finest particles. Or if a piece of the steel be shaped into a compass needle supported on a needle point bearing, it is attracted but slowly if a magnet of the size mentioned be brought to within a distance of about ½-inch of the end of the needle.

The following report was received on these steels: "Neither the Esterline nor the Leibling apparatus showed any indication that either

*Director of research department, Crucible Steel Co. of America, Pittsburgh.

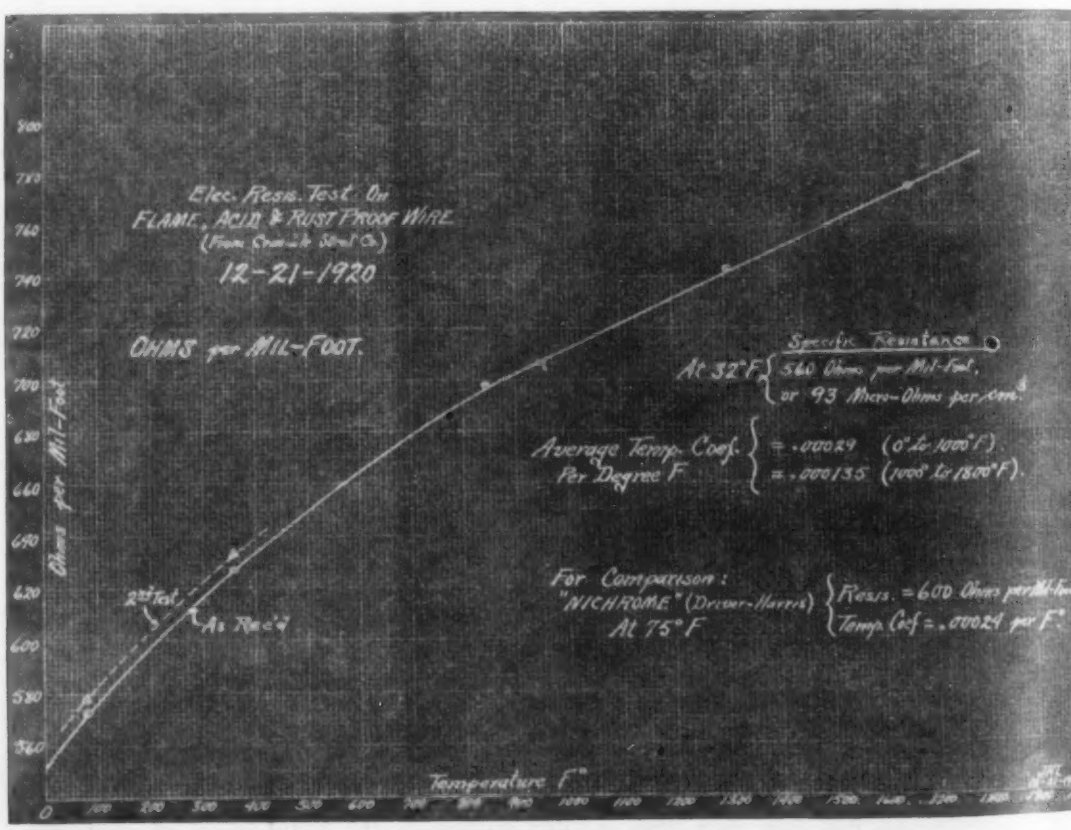


Fig. 1—Chart showing electrical resistance of grade No. 3 nonmagnetic, flame, acids and rust resisting steel at various temperatures.

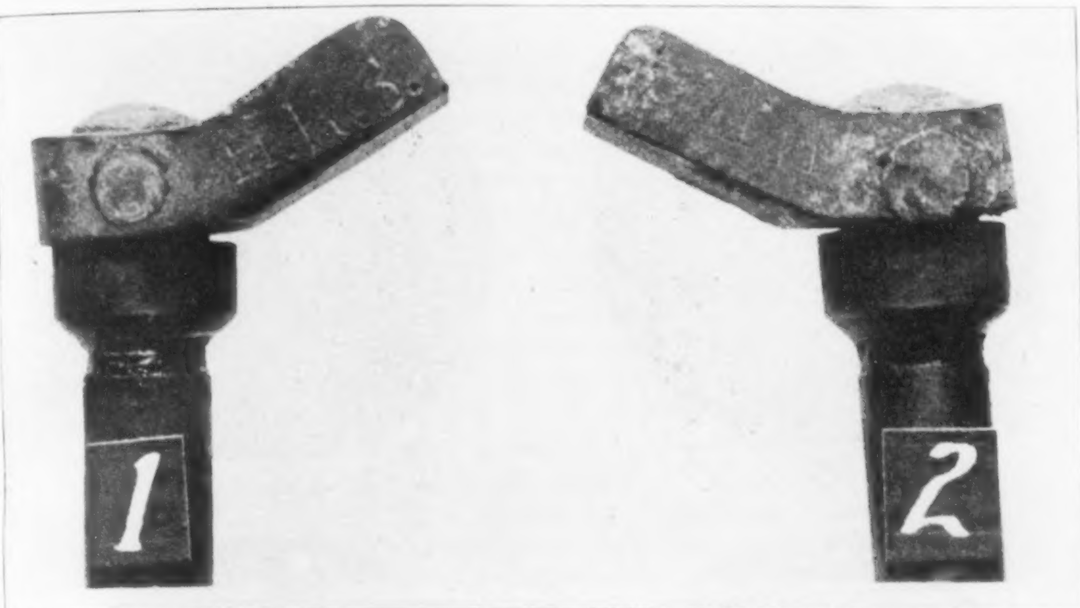


Fig. 2—Resistance of grade No. 2 nonmagnetic, flame, acids and rust resisting steel to products of combustion of fuel oils, etc. Spoon No. 1 used continuously for 110½ hours at 1500 to 1800 degrees Fahr. in combustion chamber of diesel engine burning kerosene and distillate. Spoon No. 2 used at same temperature for 103 hours in engine burning fuel oil. Both are still perfect.

grades No. 2 or No. 3 could be magnetized in the natural bar or after quenching in oil or water. The permeability in respect to air is 1.04, and after oil treating 1.06 (H Max 300.) The residual magnetism after charging did not exceed four lines per square centimeter. Both of these samples in all three conditions can be considered nonmagnetic." Also it has been noted that prolonged heat will cause an increase in its attraction by a magnet. The cumulative effect of many hours heating at the most favorable temperature has been studied.

After a number of hours heating of Grade No. 2 of these steels at a temperature approximating to 1300 degrees Fahr. it was noted that there was a decided increase in its attraction to a magnet. This increase in the attraction of this steel to a magnet was entirely lost by heating it to about 1600 degrees Fahr. for a few minutes and cooling it in air or quenching it in water.

A ¾-inch square bar of Grade No. 2 was placed in a flue and held at a temperature above a red heat for a month. The temperature given was stated as "approximate". This piece weighed 262 grams. The permanent magnet just lifted it from the table. On heating it at 1600 degrees Fahr. for 5 to 10 minutes and cooling in the air, this increase of attraction to the magnet was gone. Brinell before demagnetizing was 300 and after demagnetizing was 217. So far, the Grades No. 3 and No. 4 have not shown this gain in attraction to the magnet on prolonged heating. These same grades are lower in magnetic susceptibility than manganese steel.

The lowest temperature at which Grade No. 2 loses its slight increased magnetic susceptibility is close to 1500 degrees Fahr. (815 degrees Cent.) for instance, after so short a period of heating as 10 minutes. This slight gain in magnetic susceptibility can be restored after demagnetizing at 1500 degrees Fahr. in the same short period of 10 minutes by again heating at about 1200 degrees Fahr. If it be heated at about 1350 degrees Fahr., no restoration occurs except perhaps after several hours heating.

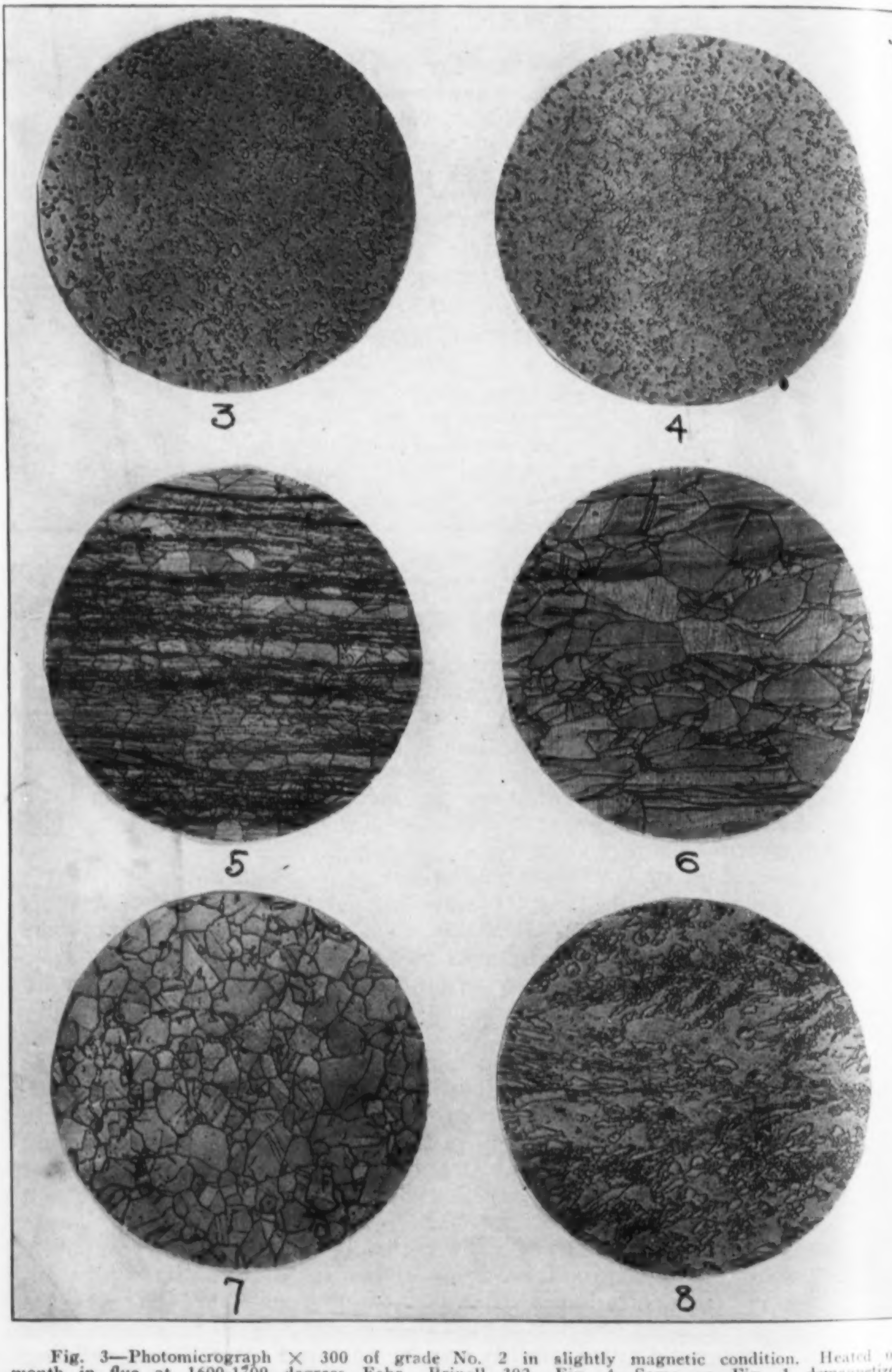


Fig. 3—Photomicrograph × 300 of grade No. 2 in slightly magnetic condition. Heated one month in flue at 1600-1700 degrees Fahr. Brinell 302. Fig. 4—Same as Fig. 1 demagnetized. Brinell 217. Fig. 5—Transverse section of grade No. 2 sheet steel etched × 300 before treatment in liquid air. Fig. 6—Same as Fig. 5 immersed in liquid air 10 minutes. Fig. 7—Transverse section of grade No. 2 natural hammered bar × 300. Brinell 228. Fig. 8—Transverse section of grade No. 3 natural ingot × 300. Carbon 1.65 percent. Brinell 302.

It is of interest to note in this connection that high carbon manganese steel of the Hadfield type shows a similar slight increase of magnetic susceptibility at about 1200 degrees Fahr. but more so at 1100 degrees Fahr. after 10 minutes heating and loses this increased susceptibility, also at about 1500 degrees Fahr. after 10 minutes. The cold drawing of Grade No. 3 increases its magnetic susceptibility to a noticeable extent. To remove this increase of susceptibility, steel is heated to 1900-2000 degrees Fahr. for a few minutes; cooled in air and heated again if necessary.

Three grades of nonmagnetic, flame, acids and rust resisting steel were immersed in boiling liquid air for 10 minutes together with a piece of ordinary sheet steel and a piece of 25 per cent nickel steel. The 25 per cent nickel steel showed a strong magnetic susceptibility about the same as ordinary steel, but inside of a minute after removing it from the boiling air, this effect was entirely gone. The three grades of nonmagnetic, flame, acids and rust resisting steel were not attracted by the magnet immediately after removing from the liquid air or when still immersed.

It was also found that while the ordinary sheet steel on being taken out of the liquid air was very brittle and could be snapped off with a pair of pliers, the nonmagnetic, flame, acids and rust resisting steel and also 25 per cent nickel steel were apparently as tough as ever, showing no indication of brittleness. Therefore, the hot rolled nonmagnetic, flame, acids and rust resisting steel can be described as tough and strong in all temperatures from — 185 degrees Cent. to + 1300 degrees Cent. which is a fairly good range. This ought to make very good material for bottles for transporting liquid air as it did not become brittle at the lower temperature.

Table I shows resistance to acids of nonmagnetic, acids, flame and rust resisting steel compared to some other metals and steels. The metals were in sheet form and immersed for 24 hours at room temperature in the following acids: Glacial acetic, 20 per cent H_2SO_4, 32 per cent HNO_3 and 19 per cent HCl. The loss in weight is given in milligrams per square inch of exposed surface.

The tests, of course, were made on samples from which all scale had been removed either by grinding or polishing.

It was an interesting fact that in some of the grades, the scale was dissolved by glacial acetic acid, discoloring the acid whereas the steel from which the scale had been thoroughly ground off showed no loss of weight and did not discolor the acid.

Table I

Nonmagnetic, Flame, Acids and Rust Resisting Steel

Grade	Glacial Acetic	32 per cent H_2SO_4	10 per cent H_2SO_4	32 per cent HNO_3	19 per cent HCl
No. 5-2		2.0			
No. 4-2	6.15	3.3	3.2	0.41	33.3
No. 3-2	0.33	6.3	5.4	0.50	41.0
No. 2-2	0.26	86.1	68.3	0.26	99.2
No. 2-2 oil 2000°F	0.15	85.9	50.8	0.93	67.1

Other Metals and Steels

Grade	Glacial Acetic	20 per cent H_2SO_4	10 per cent H_2SO_4	32 per cent HNO_3	19 per cent HCl
High Cr Ni Steel	7.93	1,045.0	111.3	0.27	462.8
High Cr Si Steel	0.00	2,180.0	..	0.50	...
25% Ni Steel	7.81	9.0	11.0	1,683.00	22.3
38% Ni Steel	13.80	4.1	4.1	3,459.00	19.0
Wrought Iron	19.30	1,122.0	490.0	1,715.00	261.5
Copper Steel	12.20	96.3	73.4	2,126.00	201.2
Monel Metal	0.70	1.2	1.3	2,157.00	13.1
High Cr Steel	0.67	2,062.0	1,262.0	0.10	437.3

Following are the results of immersing nonmagnetic, flame, acids and rust resisting steel in cold concentrated nitric acid of 1.42 specific gravity for 24 hours:

Grade	Loss per square inch
No. 2	0.37 milligram
No. 3	0.36 "
No. 4	0.37 "

The high polish of the samples was uneffected by the acid.

Table II demonstrates how this class of steel has an extraordinary high reduction and elongation at temperatures that would burn anything but high speed steels. Grade No. 2 attracts attention in this respect, that even at 2450 degrees Fahr. the reduction is 69.3 per cent, elongation 65 per cent in 2 inches and tensile strength 103,090 pounds per square inch. Grade No. 3 at 2200 degrees Fahr. had a reduction of 64.3 per cent elongation 58.5 per cent and tensile strength of 111,170 pounds per square inch.

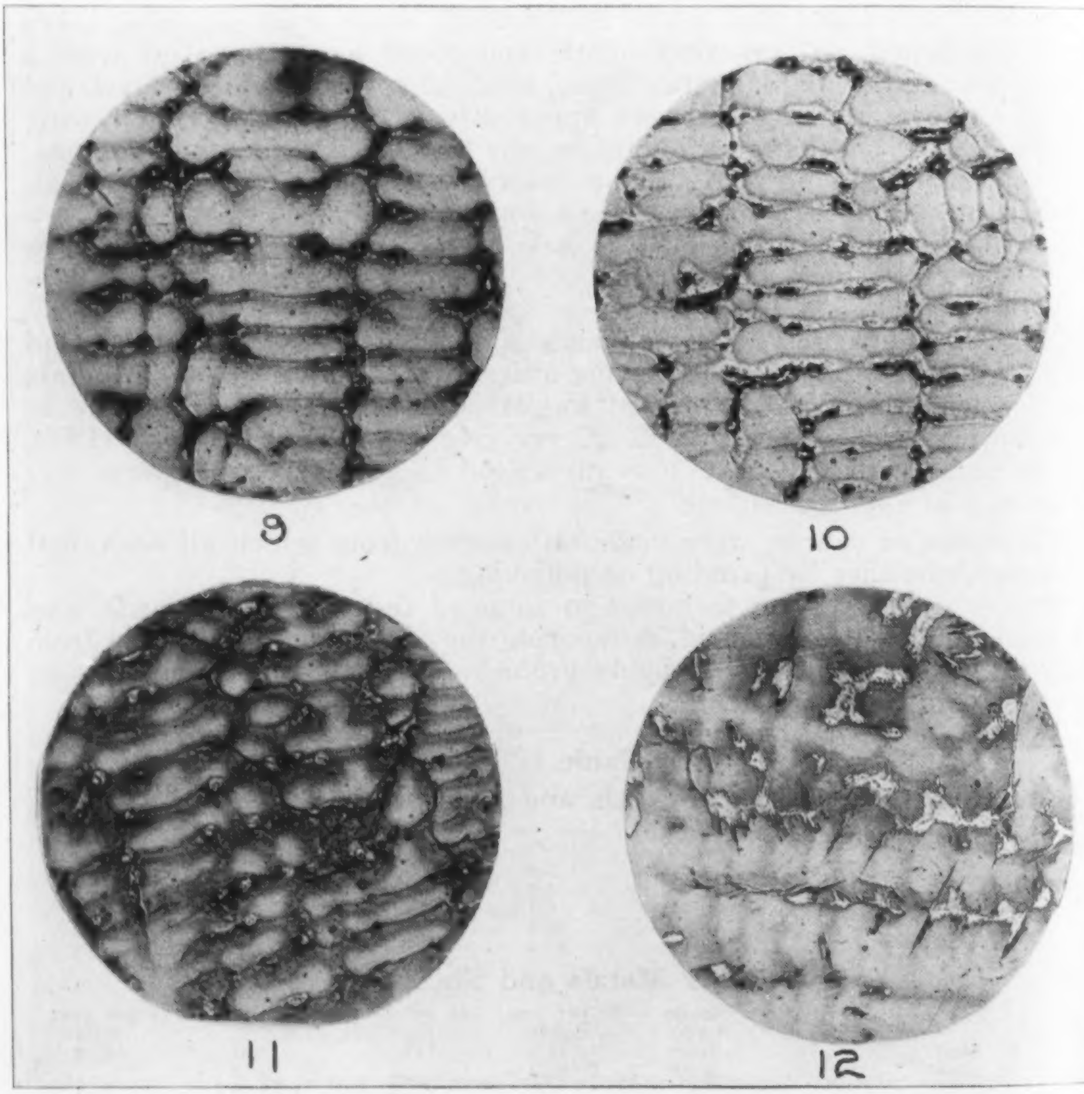


Fig. 9—Microstructure of transverse section of natural ingot grade No. 2. Brinell 179. Fig. 10—Same of grade No. 3 Brinell 187. Fig. 11—Same of grade No. 4. Brinell 166. Fig. 12—Transverse section Hadfield's manganese steel natural ingot. Brinell 302.

Tensile Strength of Cast Ingots Made From Nonmagnetic, Flame, Acids and Rust Resisting Steel, Grade No. 4

Elastic Limit	47,400 pounds per square inch
Ultimate Strength	84,480 pounds per square inch
Elongation	19.5 per cent
Reduction	16.6 per cent

This is the natural casting before it has had any annealing or heat treatment.

Table II

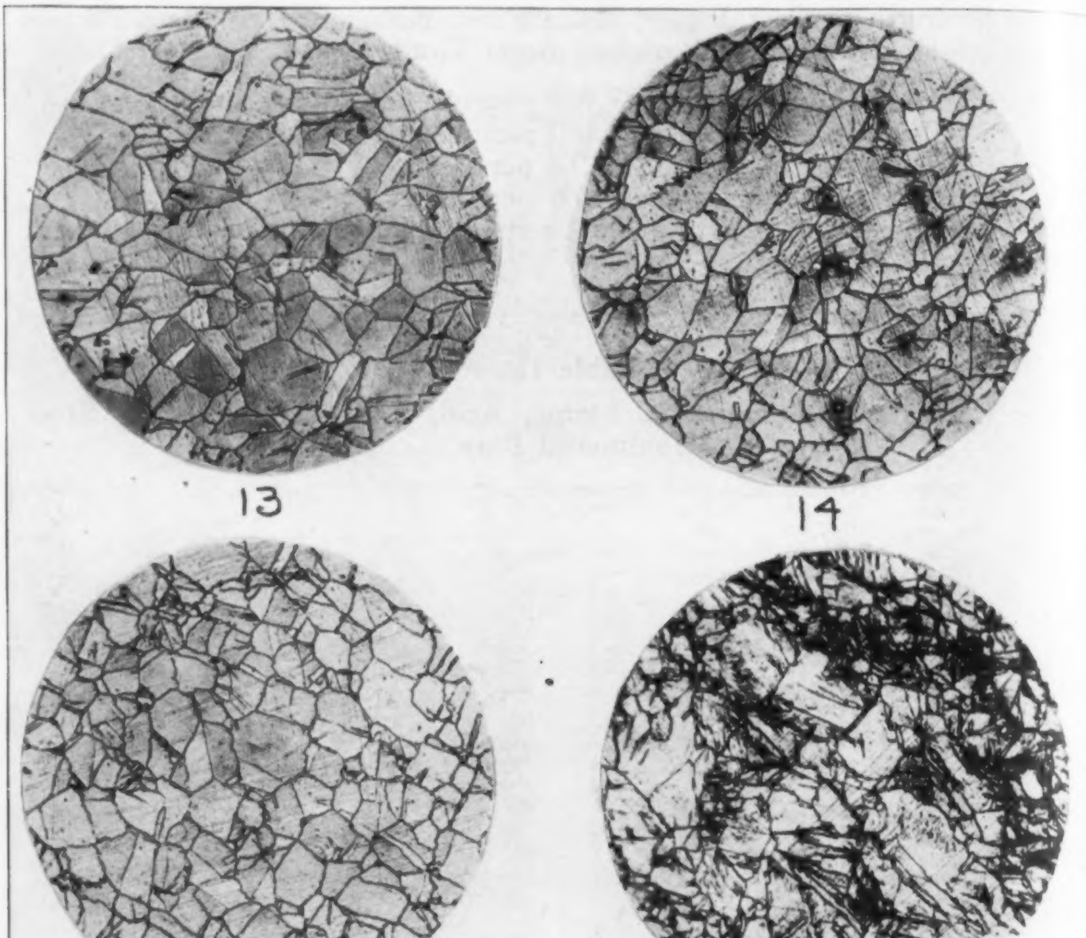
Tensile Values of Nonmagnetic, Flame, Acids and Rust Resisting Steel Hammered Bars

Grade	Yield point lbs. per sq. in.	Ultimate strength lbs. per sq. in.	Elongation in 2 in. per cent	Reduction of area per cent	Brinell	Treatment	
No. 2-1	107,270	146,870	25.5	40.1	302	Natural condition	
No. 2-1	67,750	130,000	37	46.3	228	*Quenched in air	1832° F.
No. 2-1	67,000	125,800	40.5	54.1	241	" " oil	1832
No. 2-1	79,720	131,020	37.5	49.6	241	" " water	1832
No. 2-1	53,990	103,090	65	69.3	187	* " " oil	2450
No. 2-1	56,650	109,500	67.5	67.5	187	" " oil	2400
No. 2-1	56,080	113,190	60.5	63.3	202	" " oil	2300
No. 2-1	62,000	118,400	54.5	62.3	217	" " oil	2200
No. 2-1	75,190	134,330	35	45.	269	" " oil	1650
No. 2-1	105,480	140,660	27.5	41.7	293	" " oil	1475
No. 3-2	85,710	117,990	33	48.2	228	Natural condition	
No. 3-2	61,340	111,170	58.5	64.3	196	Quenched in oil	2200° F.
No. 3-2	62,080	112,680	49	62.4	207	" " oil	2100
No. 3-2	72,700	111,650	45	61.3	228	" " oil	2000
No. 3-2	75,080	113,140	39	60	228	" " oil	1900
No. 4-5	90,220	113,030	31.5	49	228	Natural condition	
No. 4-5	55,900	110,250	47.5	60.3	187	Quenched in oil	2200° F.
No. 4-5	59,200	110,900	42.5	57.3	187	" " oil	2100
No. 4-5	56,490	107,370	44	56.8	192	" " oil	2000
No. 4-5	62,000	109,400	38.5	52.7	192	" " oil	1900

*Periods of heating 15 minutes after reaching the above temperatures.

Nonmagnetic, Flame, Acids and Rust Resisting Hot Rolled Steel Sheets. Grade No. 2-6

	Treatment	Yield point by dividers lbs. per sq. in.	Tensile lbs. per sq. in.	Per cent elongation in 2 inches	Per cent reduction in 2 inches	Shore
600° C.	air	83,950	114,600	49	45.1	50
600	oil	89,440	115,840	54.5	45.5	45
600	water	85,320	118,930	48.5	44	44
650	air	79,940	115,634	52.5	45.1	44
650	oil	94,190	120,930	51.2	41.3	45
650	water	91,575	115,700	46.5	40.4	45
700	air	91,130	122,320	29	29.1	50
700	oil	89,500	127,000	33	36.9	50
700	water	89,190	123,120	35	33	48
850	air	92,540	134,330	25.5	21.8	50
850	oil	83,530	135,330	33	30.2	50
850	water	81,270	133,530	30.5	26.6	50
900	air	79,620	130,250	33.5	28.3	50
900	oil	75,760	137,880	38.5	33.9	50
900	water	77,430	130,410	36.5	36.4	50
950	air	71,430	131,190	37	30.9	50
950	oil	74,295	131,040	41	37,9	50
950	water	79,310	130,720	40.5	37.6	50
1050	air	74,710	119,540	44	42.5	48
1050	oil	76,500	118,310	42.5	47	47
1050	water	75,370	121,670	43	39.9	46
1100	air	66,370	122,600	51	50.5	45
1100	oil	68,170	125,820	53.5	50.8	44
1100	water	64,850	115,600	47	44.7	43
1200	air	54,890	116,020	64	42.7	38
1200	oil	56,270	114,290	59.5	51	40
1200	water	55,700	98,250	59.5	47.2	36



Transverse sections of microstructure × 300 and hardening at ascending temperatures of grade No. 2-2 air cooled. All specimens held two hours including 750 degree Cent. treatment. Fig. 13—500 degrees Cent. Brinell 241. Fig. 14—550 degrees Cent. Brinell 241. Fig. 15—600 degrees Cent. Brinell 241. Fig. 16—650 degrees Cent. Brinell 255. Fig. 17—700 degrees Cent. Brinell 286. Fig. 18—750 degrees Cent. Brinell 286.

1-Inch Square Rolled Bar, Natural Condition. Grade No. 3-10

Elastic limit by strain gauge lbs. per sq. in.	Yield point by dividers lbs. per sq. in.	Tensile lbs. per sq. in	Elongation in 2 inches	Reduction in 2 inches	Brinell
90,500	99,500	134,250	29	49.2	269

Nonmagnetic, Flame, Acids and Rust Resisting Hot Rolled Sheet Steel. Grade No. 3-8

	Treatment	Yield point by dividers lbs. per sq. in.	Tensile lbs. per sq. in.	Elongation in 2 in., per cent	Reduction in 2 in., per cent	Shore
600°C.	air	114,620	126,900	32.5	39.7	55
600	oil	117,350	127,000	22.5	36.3	57
600	water	111,600	126,900	25	37.9	55
650	air	117,750	165,680	30	39.1	50
650	oil	114,680	130,580	31.5	39.1	50
650	water	112,250	130,000	33.5	38	53
700	air	107,690	133,730	28.5	38.4	48
700	oil	101,180	128,990	34.5	35.5	47
700	water	99,390	131,020	29	37.9	50
850	air	96,690	126,130	30	37.8	47
850	oil	100,290	124,780	31	35.3	45
850	water	98,500	131,340	31	37.9	47
900	air	86,110	128,400	32.5	38.8	48
900	oil	98,480	131,400	33	39.6	48
900	water	97,820	126,390	34	40.9	45
950	air	99,100	134,600	33.5	41.9	45
950	oil	87,730	132,820	33	41.4	45
950	water	92,070	129,270	34.5	40.2	47
1050	air	74,040	122,420	45	43.3	38
1050	oil	74,610	122,910	47	43.7	40
1050	water	78,710	120,690	45	45.7	40
1100	air	64,460	122,590	50	46.9	38
1100	oil	61,560	115,610	52.5	47.4	40
1100	water	73,410	116,400	49.5	48.7	40
1200	air	67,200	108,700	51.5	47	37
1200	oil	67,900	109,120	62.5	46.9	33
1200	water	57,900	99,400	60	51.1	38

Tensile Strength at High Temperature of Grade No. 3 Nonmagnetic, Flame, Acids and Rust Resisting Steel

Temperature	Tensile Strength lbs. per sq. in.	Elongation in 2 inches per cent	Reduction of area per cent
1292°F. (700°C.)	71,470	20	24.7
1472°F. (800°C.)	44,900	28.5	62.8
1760°F. (960°C.)	21,395	37.5	82.4

Tensile Strength of Carbon Steel At High Temperatures

0.76 C, 0.49 Mn, 0.174 Si, 0.016 P, 0.014 S

Temperature	Tensile Strength lbs. per sq. in.	Elongation in 2 inches per cent	Reduction of area per cent
650°C.	45,100	18.2	45.2
800°C.	10,725		100
Room Temp.	131,000	12.5	20.6

Tensile Strength After Being Heated For One Hour at 2200-2350 Degrees Fahr.

482-8 ¾″ sq. hammered bar. Cooled in air.

2200°F. lbs. per sq. in.		2350°F. lbs. per sq. in.
51,960	Yield Point	53,900
93,730	Ultimate Strength	99,240
31.5%	Elongation	43.5%
27.7%	Reduction	43.6%

These yield points were taken with dividers. Strain gauge not used.

Compression and Torsion Values, etc., on 0.038-Inch Sheets and Bars of Nonmagnetic, Flame, Acids and Rust Resisting Steel

	Tension Bar	Tension Sheet*	Compression	Shear	Torsion	Impact	Hardness**	Ductility test
Elastic limit Lb. sq. in	63,660	152,590	81,610	....	52,150	...	...	......
Yield point Lb. sq. in.	....	....	....	....	....	...	...	......
Ult. strength...	122,560	203,150	130,300	82.420	Mod. of Rupture 110,560	...	...	......
Elongation % in 2 in.	29.3	26.7	....	....	....	...	...	......
Elongation % in 4 in.	....	20.9	....	....	....	...	...	......
Reduction of area, %	43.8	....	....	....	....	...	...	......
Modulus of Elasticity ...	27,170,000	....	....	....	11,713,000	...	...	......
Ft.-lb. Energy.	....	....	....	....	....	22.8	...	......
Scleroscope ...	....	....	....	....	....	...	48	......
Brinell	....	....	....	....	....	...	244	......
90 deg. reverse bend R-3T...	....	....	....	....	....	...	...	3 to 4
Min. dia. over which can bend 180 deg. without cracking	....	....	....	....	....	...	...	4 thicknesses

*Thickness—0.038 in.

**Made on impact specimens.

Note the high physical values obtained in the sheet steel.

Results of Tension Tests at High Temperatures

Temperature	1292°F.	1472°F.	1760°F.
Ult. strength Lb./sq. in..............	52,200	29,715	9,755
Elongation per cent in 2 inches.........	23.0	42	19.5

Ductility Tests on Nonmagnetic, Flame, Acids and Rust Resisting Steel

Cold rolled .029-inch thick, 65 scleroscopic hardness, Grade No. 3				Cold Rolled .017-inch thick, 55 scleroscopic hardness, Grade No. 4		
Scleroscopic hardness	Deflection in inches	Total load in lbs. to rupture	Treatment Annealed 10 min. at	Deflection in inches	Total load in lbs. to rupture	Scleroscopic hardness
70	.099	900	500°C.	.139	1500	60
70	.084	500	550	.157	1900	60
68	.041	300	600	.131	1200	60
66	.112	900	650	.154	1500	55
62	.146	1700	700	.150	1400	51
58	.231	3800	750	.192	1800	50
45	.329	6100	800	.247	2200	42
42	.398	8100	850	*	3000	38
40	.374	6900	900	.327	3300	36
40	.371	7200	950	*	3500	35
39	.404	7700	1000	.388	4000	35
37	.403	7000	1050	.409	3900	34
36	.487	8600	1100	.550	4000	34

*Deflection not reported as piece slipped.

Impact Results on Nonmagnetic, Flame, Acids and Rust Resisting Steel. Grade No. 2-2

Size of pieces: 50 x 0 x 10 millimeters
Size of slot: 1 mi llimeter x 5 millimeters deep.
All samples held for one-half hour at temperatures given.

Treatment		Shore Hardness	Brinell Hardness	Impact ft. lbs.
Natural		47	255	24
600°C.	air	48	241	20

600	oil	50	241	18
700	air	50	255	16
700	oil	50	255	21
800	air	47	241	19
800	oil	50	241	16
900	air	48	241	16
900	oil	47	228	22
1000	air	40	196	39
1000	oil	40	235	27
1100	air	38	196	39
1100	oil	40	192	44
1200	air	31	156	48
1200	oil	30	149	52

Test pieces showing 52-53 foot pounds did not break; they simply bent over.

Specific Gravity of Nonmagnetic, Flame, Acids and Rust Resisting Steel and Monel Metal

Grade No. 3 Rezistal (Sheet) 7.782
Grade No. 4 Rezistal (Sheet) 7.763
Grade No. 4 ¾-inch Hammered Bar: heated to 2200°F. Quenched in oil 8.871
Pure Iron 7.870

Impact Results on Nonmagnetic, Flame, Acids and Rust Resisting Steel. Grade No. 3-10

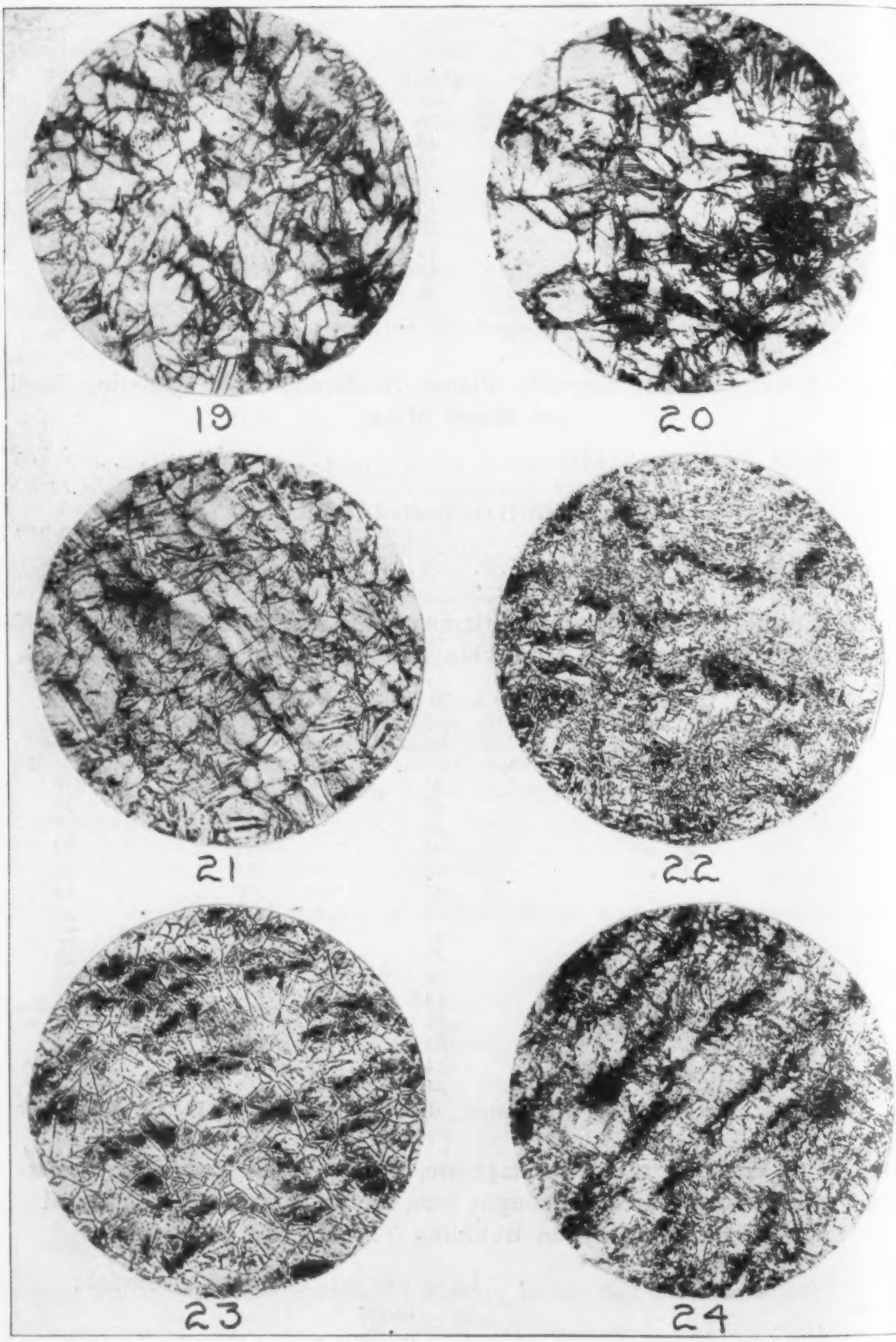
Size of pieces: 50 x 10 x 10 millimeters.
Size of slot: 1 millimeter wide x 5 millimeters deep.
All samples held for one-half hour at temperatures given.

Treatment		Shore Hardness	Brinell Hardness	Impact ft. lbs.
Natural		46	228	18
600°C.	air	46	228	19
600	oil	46	217	25
700	air	46	228	22
700	oil	45	217	20
800	air	45	207	18
800	oil	45	207	22
900	air	43	207	22
900	oil	45	196	22
1000	air	38	163	33
1000	oil	43	179	36
1100	air	34	163	36
1100	oil	33	163	44
1200	air	34	163	51
1200	oil	34	159	53

Test pieces showing 52-53 foot pounds did not break; they simply bent over.

Oxygen and Water Attack Nonmagnetic, Flame, Acids and Rust Resisting Steel, Stainless Steel, Wrought Iron and Monel Metal Immersed in Water With Oxygen Bubbling Through for 24 hours

Grade	Loss per sq. in. exposed surface
No. 3	none
No. 4	none
No. 5	none
Stainless	none
Wrought Iron	7.200 mg. (badly corroded)
Monel Metal	.077 mg.



Transverse sections of microstructure × 300 and hardening at ascending temperatures of grade No. 2-2 air cooled. All specimens were held one hour. Fig. 19—800 degrees Cent. Brinell 262. Fig. 20—850 degrees Cent. Brinell 269. Fig. 21—900 degrees Cent. Brinell 269. Fig. 22—950 degrees Cent. Brinell 241. Fig. 23—1000 degrees Cent. Brinell 241. Fig. 24—1050 degrees Cent. Brinell 241.

Thermal Expansion of Nonmagnetic, Flame, Acids and Rust Resisting Steel

Temperature Range	Average Coefficients of Expansion per Degree Centigrade. Sample No. 3	Sample No. 4
20° to 300°C.	0.0000163	0.0000159
300 " 600	.0000180	.0000179
600 " 900	.0000200	.0000204

The above determinations were made by the Bureau of Standards, Washington, D. C.

The steel when attacked by the oxyacetylene flame requires 20 times as long to melt a hole through it as it does to melt a hole through ordinary steel.

High chromium steel after 30 minutes exposure to oxidizing flame in a gas furnace at a temperature of 2000 degrees Fahr. loses 520.5 milligrams per square inch of exposed surface. The flame resisting steel suffers only a slight staining and a slight gain in weight per square inch after several hours heating at 1900 to 2000 degrees Fahr.

Table III shows resistance to scaling of nonmagnetic, flame, acids and rust resisting steels compared with some other metals and steels. The specimens were ground smooth, weighed, cooled in air and weighed again and loss and gain in weight calculated to milligrams per square inch.

Table III

Nonmagnetic, Flame, Acids and Rust Resisting Steel

Grade	Loss	Gain
No. 2-2	none	4.8 mg
No. 3-2	none	4.6 mg
No. 4-5	0.3 mg	none
No. 5-1	0000	0000

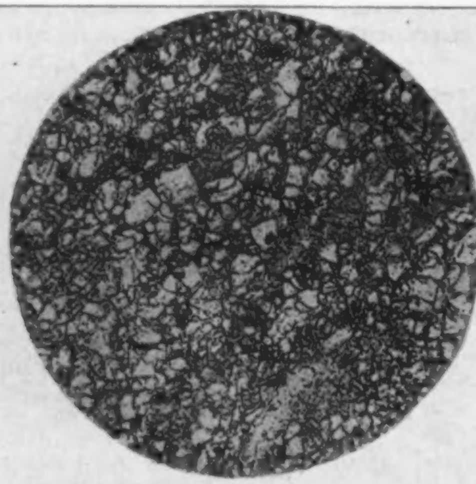
Other Metals and Steels

Grade	Loss	Gain
Monel Metal	338 mg	no gain
96% Nickel	15 mg	adherent scale
High Cr-Ni Steel	57.1 mg	....
Grade A Steel	No loss	1.2 mg.
High Cr Steel	520.5	
Copper Steel	967.4	

Grade	1200°C. Gain	90 minutes Loss
No. 3	none	1.5
No. 4	0.5	none
No. 5	none	1.5

It was found that copper would not plate on grades Nos. 3 and 4 on the clean metallic surface either in the neutral or acid solution of copper sulphate at room temperature or at boiling temperature. Copper plates readily on high chromium steel when immersed in either neutral or acid solution of copper sulphate.

These steels will remain for days immersed in ordinary drinking water developing only very slight rust stain. In making such tests, all roll or hammer scale must be removed as the action of water on scale causes rust stains. They show the highest resistance to all fruit acids and staining in general. Paring knives made from grade No. 2 not only never stain, but do not stain the operator's fingers. It must be



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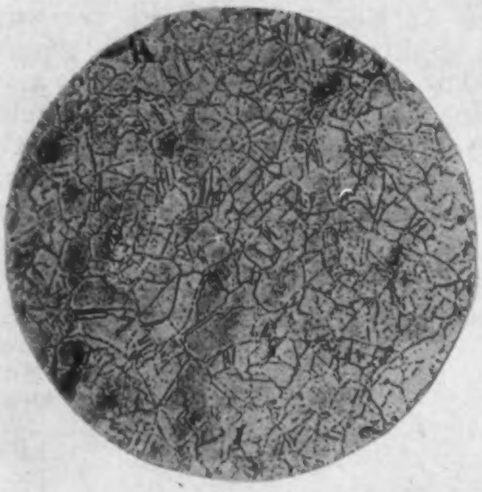

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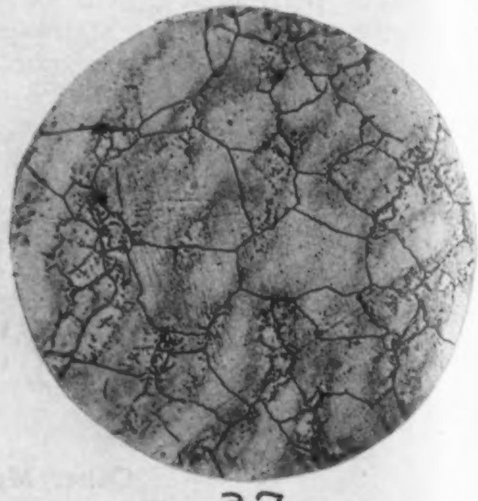

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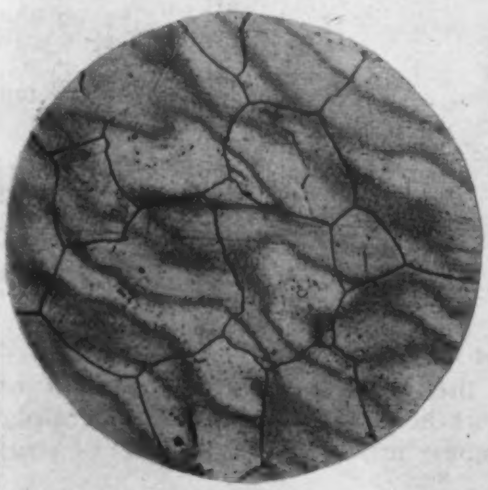

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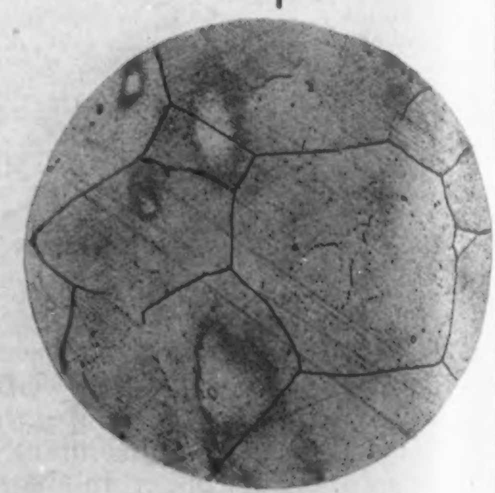

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Transverse section of microstructure × 300 and hardening at ascending temperatures of grade No. 2-2 air cooled. 1100 degree Cent. Specimen held one hour, remainder five minutes. Fig. 25—1100 degrees Cent. Brinell 223. Fig. 26—1150 degrees Cent. Brinell 217. Fig. 27—1200 degrees Cent. Brinell 179. Fig. 28—1200 degrees Cent. Brinell 174. Fig. 29.—1300 degrees Cent. Brinell 156.

noted, however, that handles for such knives must be wooden or fiber ones as any metal handles made of other than stainless materials might cause staining of one's fingers even though the blade did not stain. No heat treatment is required to render the steel stainless and rust resisting to the highest degree. Progressive rusting is extremely slow.

The following tests were made on grade No. 3 nonmagnetic, flame, acids and rust resisting steel in a small casting as follows: A wash heat of lead was first made in the cast crucible. The molten lead was poured out and the crucible freed from any adhering buttons of lead. It then weighed 1208 grams. It was then refilled with fresh lead and kept at 900 degrees Cent. (1650 degrees Fahr.) for 8 hours in a gas furnace and the lead was again poured out and the crucible weighed 1208.43 grams. No scaling occurred on the outside of the crucible. This would indicate that lead has little or no effect on nonmagnetic, flame, acids and rust resisting steel and neither has the gas flame at this temperature.

Grade No. 3 was also tested by immersing it in sodium cyanide for one hour at 1000 degrees Cent. Also a piece of wrought iron and a piece of copper steel at the same time. The wrought iron and the copper steel lost three times as much weight as the nonmagnetic, flame, acids and rust resisting steel per square inch of immersed surface. The results were as follows:

Grade No. 3 lost 153.6 milligrams per square inch.
Copper steel lost 482.5 milligrams per square inch.
Wrought iron lost 478.1 millgirams per square inch.

Following are the effects of (1) Salt Solution, (2) Quick Lime, (3) Portland Cement, (4) Concentrated Solution of Carbolic Acid, (5) Saturated Solution of Oxalic Acid (6) Hot Asphaltum, (7) Glacial Acetic Acid, (8) Silver Nitrate Solution, (9) Saturated Potash Alum Solution, (10) Hot 20% Caustic Soda Solution, (13) Fresh Butter and Stale Butter, (14) Immersion in Sulphurous Acid.

1. Only slight color tarnish when immersed for 72 hours in saturated salt solution.

2. No change of luster and no loss when imbedded in pasty quick lime solution for 171 hours.

3. Imbedded in pasty portland cement solution for 22 days and allowed to set; luster unchanged.

4. No loss of weight; merest trace of discoloration after 92½ hours in concentrated carbolic acid.

5. Slightly etched in spots after 90 hours in oxalic saturated solution, lost 1.41 milligrams per square inch.

6. Hot asphaltum—Kept in molten asphaltum for one hour; allowed to cool. No loss in weight; slight discoloration suggesting enamel.

7. Glacial acetic acid has no effect in the cold and no discoloring after ninety hours and no discoloration of the glacial acetic acid.

8. This steel when immersed in silver nitrate solution either in the cold or for several hours at 75 degrees Cent. keeps its original luster.

9. After 22 hours immersion in a cold saturated alum solution, this steel shows some slight etched spots. Hot saturated solution attacks the steel slightly more.

10. Polished piece of this steel kept in boiling hot 20 per cent caustic soda solution for 3 hours loses no weight and maintains its original polished surface.

11. Immersion in 30 per cent Sulphuric Acid for one week at Room

Temperatures.

Loss per square inch of exposed surface

Monel	4.2 mg
Meco	3.6 mg
Grade No. 5	5.7 mg

12. Grades Nos. 3, 4 and 5 are highly resistant to nitric acid up to at least 30 per cent strength, whereas, meco and monel are dissolved by nitric acid.

13. Polished samples of grades Nos. 2, 3, 4 and 5 were put into fresh butter and also into butter that was one month old and quite gassy for 8 days at room temperature. On removing the samples and cleaning the same with gasolene, no change of weight could be detected on a delicate analytical balance and the samples were as highly polished as ever.

Immersion in Sulphurous Acid

14.

Grade	1st 2% SO_2 16½ hrs. in cold Loss per sq. in.	2nd 2% SO_2 22 hrs. in cold Loss per sq. in.	3rd 1% SO_2 46 hrs. in cold Loss per sq. in.	4th 1% SO_2 22½ hrs. in cold Loss per sq. in.	5th 2% SO_2 24 hrs. in cold Loss per sq. in.
No. 2	14.7 mg.	19.0 mg.	20.4 mg.	12.2 mg.	
No. 3	7.6 "	0.3 "	10.0 "	0.3 "	12.2 mg.
No. 4	2.3 "	2.4 "	3.3 "	4.0 "	
No. 5	3.6 "	3.2 "	3.4 "	4.1 "	
Monel	0.7 "	1.0 "	1.6 "	1.0 "	
Wrought Iron	1st-37.6 mg. 2nd-39.8 mg. 3rd-88.7 mg.				

Grade No. 3 after first exposure to sulphurous acid solution lost 7.6 milligrams as shown above in Column 1, but on being removed from the first solution and put in fresh sulphurous acid, it was practically unattacked as shown in Column 2, resisting even better than monel metal at this stage. Grade No. 3 took on a dark protective coating which prevented further attack. This curious fact was confirmed by five independent experiments. The fact that the sulphurous acid had no effect on second immersion in fresh acid solution was further proven by the sulphurous acid retaining its strength and showing no cloud of sulphur.

When a sample is attacked, a strong smell of hydrogen sulphide is first noticed followed by an immediate clouding of the liquid with white milk of sulphur. The following equations explain what happens as these tests were made in tightly stoppered bottles to prevent escape of SO_2:

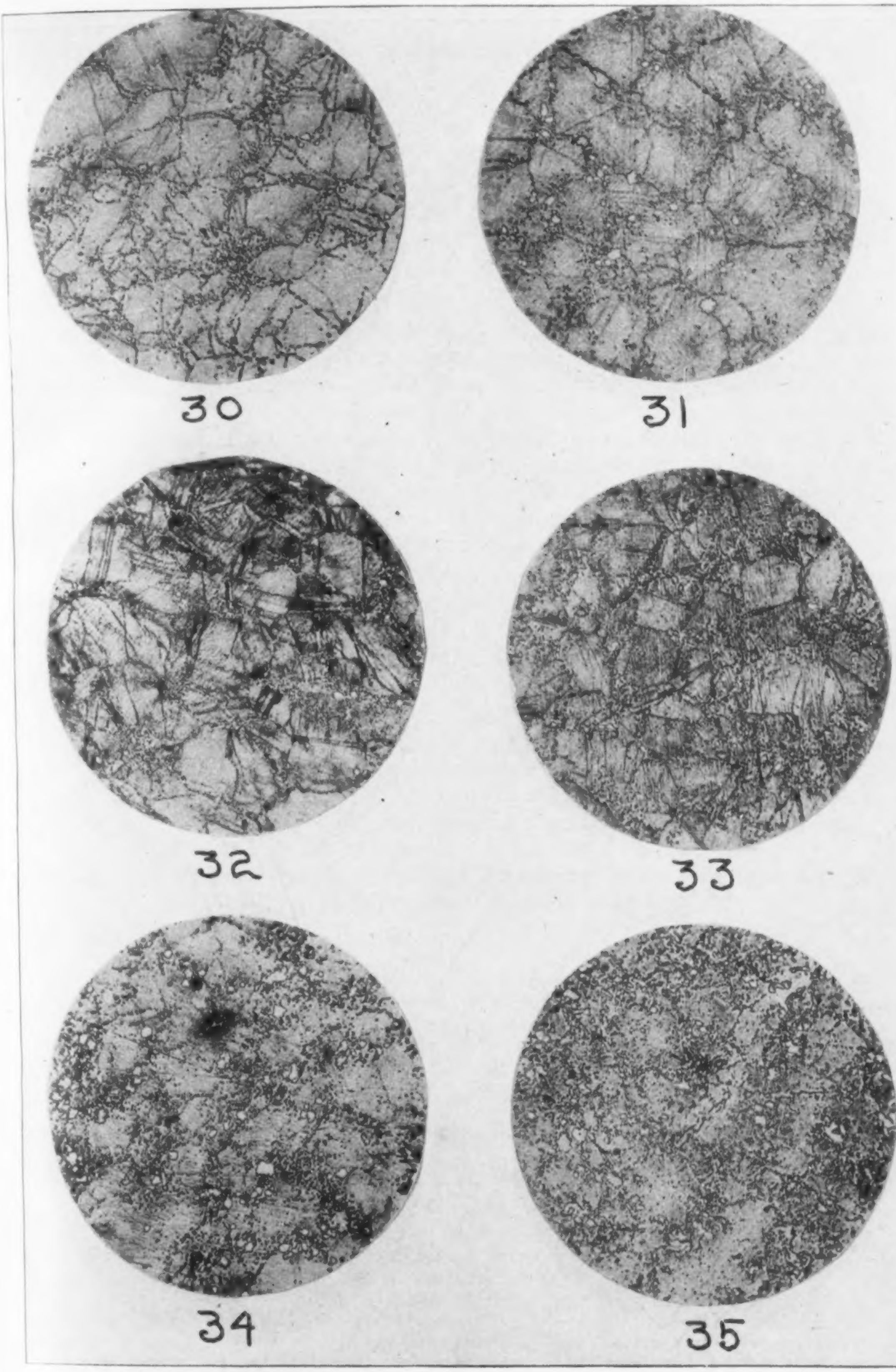
$$(1) \quad SO_2 + 3\ F_e + H_2O = H_2S + 3\ F_eO$$

$$(2) \quad SO_2 + 2\ H_2S = 2H_2O + 3S$$

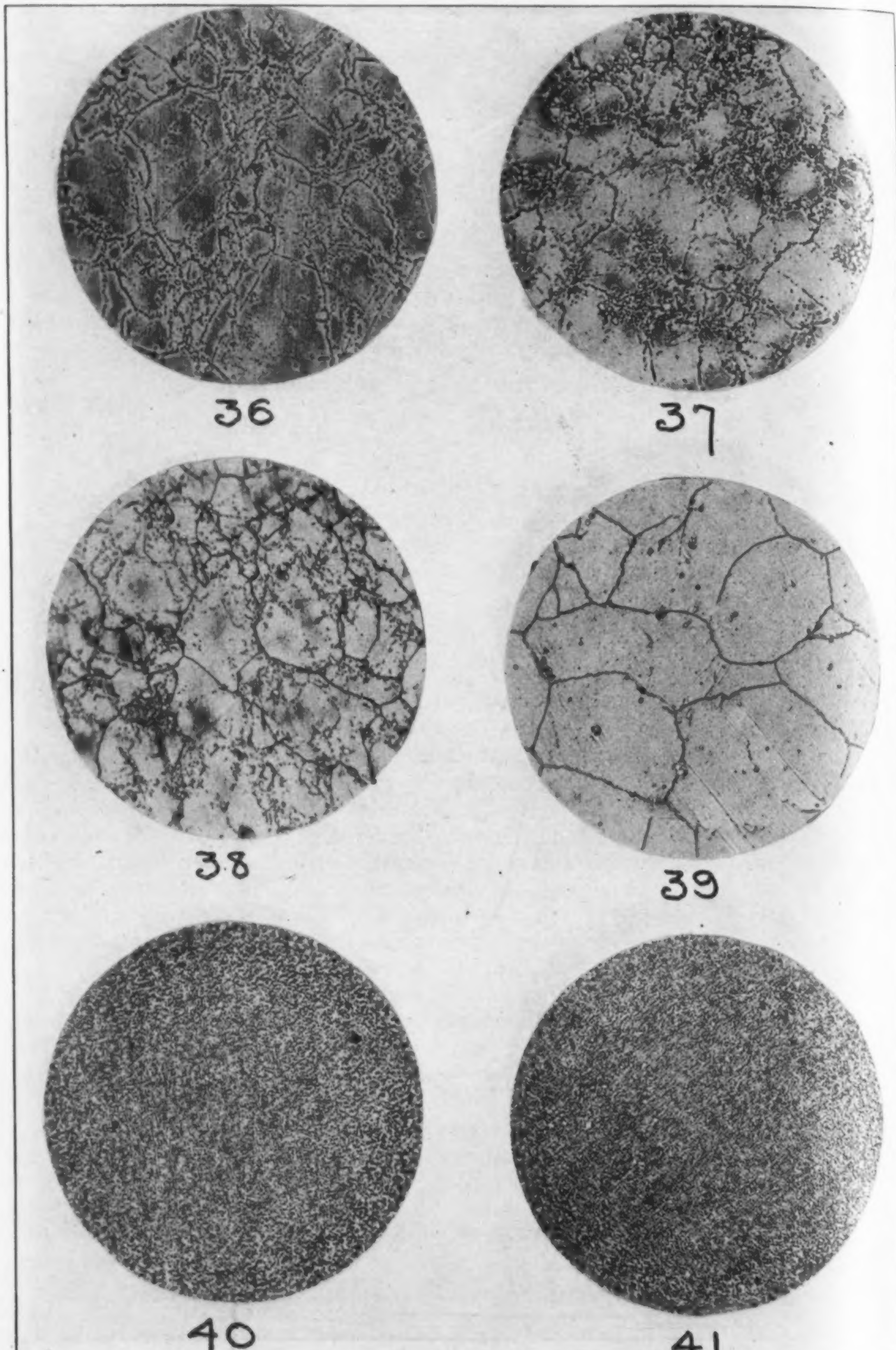
The following table shows resistance to scaling of nonmagnetic, flame, acids and rust resisting steel compared with some other metals and steels. The specimens were ground smooth; weighed and measured; then heated to 1150 degrees Cent. for ½ hour in a gas furnace; cooled in air; and weighed again and loss and gain in weight calculated to milligrams per square inch.

Nonmagnetic, Flame, Acids and Rust Resisting Steel

Grade	Loss	Gain
No. 2-2	none	4.8 mg
No. 3-2	none	4.6 mg
No. 4-5	.3 mg	none
No. 5-1	0000	0000



Transverse sections of microstructure × 300 and hardening at ascending temperatures of grade No. 3-2 air cooled. Specimens up to and including 750 degrees Cent held two hours, above 750 degrees Cent. held one hour. Fig. 30—550 degrees Cent. Brinell 228. Fig. 31—650 degrees Cent. Brinell 255. Fig. 32—700 degrees Cent. Brinell 241. Fig. 33—750 degrees Cent. Brinell 235. Fig. 34—800 degrees Cent. Brinell 235. Fig. 35—950 degrees Cent. Brinell 217.



Transverse sections of microstructure $\times$ 300 and hardening at ascending temperatures of grade No. 3-2 air cooled. 1050 degrees Cent. specimen held one hour, remainder including 1300 degrees Cent. held five minutes. Fig. 36—1050 degrees Cent. Brinell 207. Fig. 37—1150 degrees Cent. Brinell 207. Fig. 38—1200 degrees Cent. Brinell 179. Fig. 39—1300 degrees Cent. Brinell 159. Fig. 40—High chromium steel, 650 degrees Cent. Held two hours. Shore 45. Fig. 41—High chromium steel. 800 degrees Cent. Held one hour. Shore 53.

Other Metals and Steels

Grade	Loss	Gain
Monel Metal	338 mg	no gain
95% Nickel	15 mg	adherent scale
High Cr-Ni Steel	57.1 mg	
Grade A Steel	no loss	1.2 mg
High Cr Steel	520.5 mg	
Copper Steel	967.4 mg	

This steel scales very little at 1800 degrees Fahr. even after long periods of heating.

For machining, this steel should be heated at about 800-850 degrees Cent. and held there until thoroughly heated and then allowed to cool down to room temperature before it is taken out of the furnace. After annealing at 850 degrees Cent. and cooling in the furnace to room temperatures, the steel can be machined, drilled or milled with high speed tools. For cutting off to length, a friction saw running at high speed or a thin carborundum wheel can be used. The best method found so far is to use a thin metal slitting saw of regular standard high speed steel. This steel cannot be cut successfully with an ordinary hack saw.

Steel should be brought to a temperature of 1150-1200 degrees Cent. and held at this temperature for one half hour in thicker sizes. In thin sheets, it need not be held more than 5 or 10 minutes; then turned over and held 10 minutes more. It should then show a scleroscope hardness of 30.

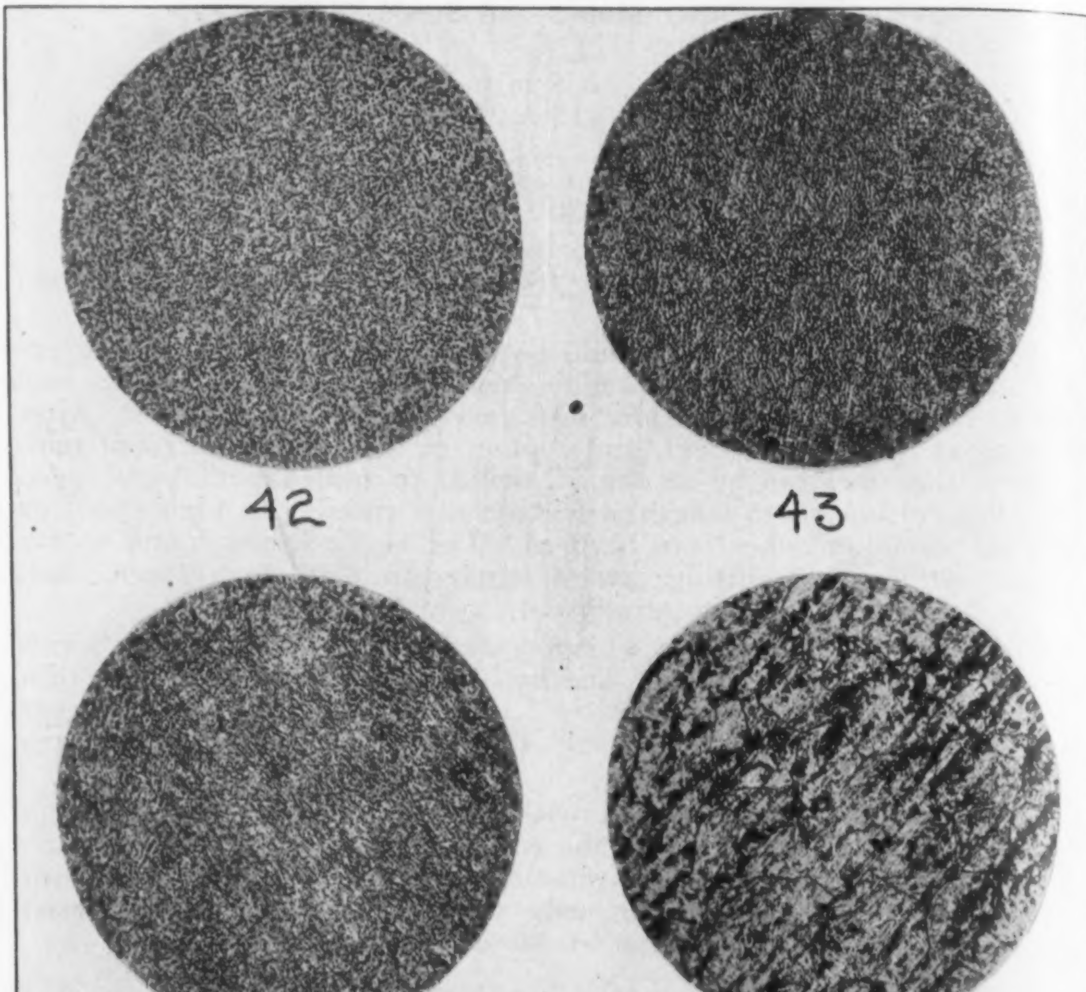
This steel can be welded best with the oxyacetylene flame using a strip of the same material to fuse the edges together and a suitable flux. The sand blasted or pickled sheets should weld the best as if scale be still on the sheets, it may interfere seriously with the welding. This material gives excellent welds on cast iron by the electrical welding method.

Nonmagnetic, Flame, Acids and Rust Resisting Steel and Stainless Steel in 1/1000 Mercuric Chloride Solution

Polished sheet	Loss after 120 hours cold	Loss after ½ hour boiling	Appearance of sample at finish	Solution at finish
Grade No. 3........	0.45 mg.	2.1 mg.	Bright; lustrous	Small white deposit at bottom of solution
Grade No. 4........	3.1 mg.		Bright; lustrous; very slight stain	Slight brown deposit at bottom of solution
Hardened stainless..	4.3 mg.	2.5 mg.	Bright; lustrous	Brown deposit at bottom of solution

Nonmagnetic, Flame, Acids and Rust Resisting Steel and Stainless Steel in Lactic Acid Attack

Grade	Time	Reagent	Loss per sq. in. in exposed surface	Effect
No. 6	24 hrs.	0.2% Lactic	none	No noticeable attack
No. 4	"	"	none	No noticeable attack
No. 3	"	"	0.4 mg.	Solution faintly yellow
No. 6	24 hrs.	1% Lactic	0.1 mg.	No noticeable attack
No. 4	"	"	0.86 "	Sample became tarnished; decidedly yellow solution.
No. 3	"	"	1.4 "	More pronounced tarnish than H-46; deep yellow sol.



Transverse sections of microstructure × 300 and hardening at ascending temperatures of high chromium steel air cooled. Specimens including 1050 degrees Cent. held one hour, remainder five minutes. Fig. 42—900 degrees Cent. Shore 72. Fig. 43—1050 degrees Cent. Shore 80. Fig. 44—1150 degrees Cent. Shore 85. Fig. 45—1200 degrees Cent. Shore 76. Fig. 46—1250 degrees Cent. Shore 78. Fig. 47—1300 degrees Cent. Shore 78.

No. 6	24 hrs.	5% Lactic	none	
No. 4	"	"	0.85 mg.	
No. 3	"	"	1.02 "	
No. 6	24 hrs.	20% Lactic	none	
No. 4	"	"	0.94 mg.	
No. 3	"	"	1.46 "	
Regular Stainless unhardened	"	"	51.85 "	Developed dark coating that rubbed off in washing; leaving clean etched surface; green solution.

Nonmagnetic, Flame, Acids and Rust Resisting Steel Attack by Water Through Which a Stream of Carbon Dioxide Is Passing

Loss in milligrams per square inch exposed surface 41 hours at 20° C.		Appearance of sample at finish.	Appearance of liquid at finish.
482-8	No loss	Absolutely no signs of tarnish or attack lustrous.	Water white, clear.
500-1	0.054 mg.	Bright and lustrous, no discernable attack.	Faint, yellowish tinge.
Monel	3.01 mg.	A loose coating of brown and yellowish green rust metal smoothly etched.	Yellowish-green deposit settled out on standing. Sample showed signs of attack after 10 minutes immersion.
0.50 carbon Plain steel	7.18 mg.	Loose yellow rust in considerable quantity. Sample attacked quickly after immersion. Metal etched, dark gray color.	Yellow rust settled out bulky precipitate.

Nonmagnetic, Flame, Acids and Rust Resisting Steel and Monel Metal in Gasoline

Grade	Reagent	Time	Loss per sq in. exposed sur.	Effect on sample	Cleaned with warm water and soap
No. 4	Gasoline	30 days	0.63 mg.	Slight brown spot on surface.	Very slight etching.
No. 3	"	" "	0.73 "	Slight brown spot on surface.	Very slight etching.
Monel	"	" "	4.08 "	Tar-like coating over entire surface.	Luster dulled.

Tensile Strength of Nonmagnetic, Flame, Acids and Rust Resisting Wire, Grade No. 4 in Cold Drawn Condition

Size	Area	Breaking load	Lbs. per sq. in.
	Cold Drawn Condition		
.148	.0172	2650	154,000
.125	.01227	2020	164,500
.064	.003217	560	175,000
.054	.0029	530	182,600
.047	.001734	375	216,800
.041	.00132	350	265,000
.032	.0008	180	225,000
	Annealed Condition		
148	.0172	2020	117,500
.125	.01227	1375	112,000
.064	.003217	475	148,500
.054	.0029	300	103,500
.047	.001734	240	138,500
.040	.00132	255	192,800
.032	.0008	160	200,000

Suggested Uses For Nonmagnetic, Flame, Acids and Rust Resisting Steel

Boiler tubes—either water or fire tubes.

*Rails, racks and trays where ordinary steels scale heavily at temperatures ranging from 1600 to 1800 degrees Fahr. in enameling furnaces.

*Valves and parts for internal combustion engines to resist high temperatures together with corrosive fumes.

*Cooking utensils such as pots, skillets, etc., that are to be kept bright; spatulas, paper cutters, trays in gas ranges that burn and rust readily when made of ordinary steel.

*Vault plates and hinges that are to resist attack of oxyacetylene flame and burglars' saws and drills.

Boxes for safe deposit vaults.

Planes for aircraft being light and having great strength and ductility in thin sections for highly stressed parts.

Oil burners.

Tips for oxyacetylene cutting torches.

Roof gutters and conductors.

*Annealing boxes; case hardening boxes.

*Flue dampers in furnace stacks.

Check valves and valves of all kinds in steam lines.

Pipes and tanks for carrying commercial sulphuric and nitric acids at atmospheric temperatures.

Pipes for corrosive mine waters.

Pickling vats and rods for same.

Nails for resisting acids.

*Rivet heating furnaces.

Hotel and kitchen cutlery nonbreakable super-stainless that can be easily sharpened requiring no heat treatment by the cutlery manufacturer.

Saw tooth bread and cake cutters.

Rust resisting tapes.

*For instruments in all places where a steel is desired that is of the lowest magnetic susceptibility.

*Containers for acetic acid and other corrosive organic acids.

Hot plates in laboratories being highly resistant to acid and heat attack.

Long life muffles for heat treating furnaces that do not operate above 2000 degrees Fahr. or use low pressure air for shorter life period at 2100 degrees Fahr.

Hoods and running boards for automobiles.

Turbine blades.

Fertilizer pans.

Tubes for annealing needles.

Dies for die casting.

*Shafts for motor boats to resist sea-water.

Pyrometer protection tubes.

Valves and valve seats for steam traps.

*Paring knives for fruits, potatoes, etc.—no staining of either steel or the operator's fingers.

Polished surface of flat irons.

Golf sticks.

Hooks and wires for suspending parts to be hardened in high temperature hardening such as high speed steel.
Fuel feeder sheet steel.
Tanners tanks, perforated bottoms.
*Gun barrels—rifle and shot gun barrels—stainless, nonrusting and noncorroding from ammunition.
Art Vases and statuettes.
Spoons—Stainless spoons will not tarnish as silver does.
Tunnels for manufacture of lamp black.
Spokes—Wire spokes for automobiles, motorcycles, bicycles, etc.
Burial caskets—Highest resistance to rusting.
*Cast lead pots—no scaling loss.
*Cast cyanide pots.
Cast annealing boxes.
Cast parts of rivet heating furnaces. (castings)
Mine water pumps and machinery being highly resistant to cold sulphuric acid.
Castings in general for resistance to acetic, sulphuric, and nitric acids at ordinary temperatures and to scale loss at temperatures up to 2000 degrees Fahr. and rusting.
*Wire— Rust resisting wire for umbrellas.
*Wire— of high electrical resistance; 560 ohms to mil foot.
Wire— of great toughness and rust resistance for mine cables and cables for incline planes.
Runners for ice boats.
Punties for polishing glass.
Rods for skimming brass.
*Hardening trays for steel stamps; splendid reports—no warping.
Wire to stand red heat continuously for shoe machinery work—No. 3 stands well; No. 4 better.

The uses marked with an asterisk (*) have already been tried and found to be successful.

FACTORS GOVERNING THE PRODUCTION OF HEATED PRODUCTS

By J. A. Brown*

(A Paper Presented at the Philadelphia Convention)

In the production of a heated product, particularly that in which heat treatment is a part, it is necessary to select that form of equipment and fuel adapted to the individual plant conditions, which when properly combined and operated will produce the result sought. In general terms this may be summed up as producing a finished product of given quality at minimum cost.

To produce this result the principal factors to be considered may be grouped under three principal heads; the first is the quality of finished product; the second the facilities available or required to produce this product, these in turn determining the cost of the finished product.

The quality of the product depends upon the raw material and upon the heat treatment it receives. The term raw material is here used in its economic sense in that the finished product of one group of producers becomes the raw material of the following group. Each step requires a definite combina-

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tion of material, process and skilled effort for its transformation. Raw material, before heat treatment, includes material more or less fabricated, having been cast, rolled, or forged at working temperatures considered suitable for these operations but with, perhaps, indifferent or little attention given to the resulting structure or condition. The chemical analysis probably checks within the limits required by the specifications, but the physical properties and structure may indicate considerable lack of uniformity in the material submitted to heat treatment. This condition merits far more attention than it has received, as every heat treater is familiar with many instances in which the after treatment is expected to restore those properties that have been sacrificed in working the raw material.

Heat treatment is commonly understood to consist of a definite succession of heating and cooling operations and the heat treatment as a process is good or bad to the extent that these operations are made definite and that the variables involved may be controlled. Control requires the duplication of condition and results and demands a high degree of standardization. Thermally, heat treatment simply covers an interchange of heat, and the thermal action is between two substances, one giving up heat and the other receiving it. A hotter fluid, flame or substance surrounds or plays on a cooler substance or object and, due to the difference in temperature, the cooler object becomes heated and the surrounding substance loses heat. The manner in which the heat is applied determines the uniformity with which the heat is absorbed.

In order that the change in the structural composition of the metal may be unobstructed, it is a fundamental requirement that the heating and the cooling should be uniform. Uniformity in heating produces the required structure in the least time with the least expenditure of heat energy, while uniformity in cooling fixes the final structural composition.

For every piece subjected to heat treatment this question must be answered: "What temperature is required?" and a workable answer depends upon data of various natures resulting from actual investigation. Fundamentally, it is a question for the metallurgist to answer correctly and fix the degree of heat required in a given operation. In a physical sense, the temperature variation in and around the piece being heated and the degree of accuracy with which this temperature variation may be controlled determines the uniformity of heating.

Equally important is the time in which the material is heated or held at temperature before cooling. Time depends not only on the mass of the material but on the surface exposed. The relation of mass and surface is a function of the shape and it is readily appreciated that an irregular shape with unequal metal thickness offers more difficulties than a simple shape of uniform thickness. Heat transfer can only take place where a temperature difference exists. The greater the temperature difference, the more rapid the flow. As the difference becomes less the flow decreases until equilibrium or saturation is reached. Obviously the temperature in the heating zone should not be higher than the temperature required for the operation or process, though it is evident that a longer time will be required to heat. In forge shop practice high temperature and incomplete saturation are responsible for the socalled wash heats, where the surface of the metal may be dripping and yet a hard core will be found in working under hammer or press.

The atmosphere in the furnace has a very direct effect on the quality of finished product. This atmosphere or condition in the furnace may result

from the fuel used or from the conditions under which the fuel is burned. Soot and ash result from the physical condition under which a fuel is used, soot indicating unconsumed fuel. Ash is frequently a troublesome feature, when coal is used in powdered form. Some operations require a clean fuel and we find anthracite in use in the soft coal districts and natural gas in the ceramic and glass industries of the Middle West.

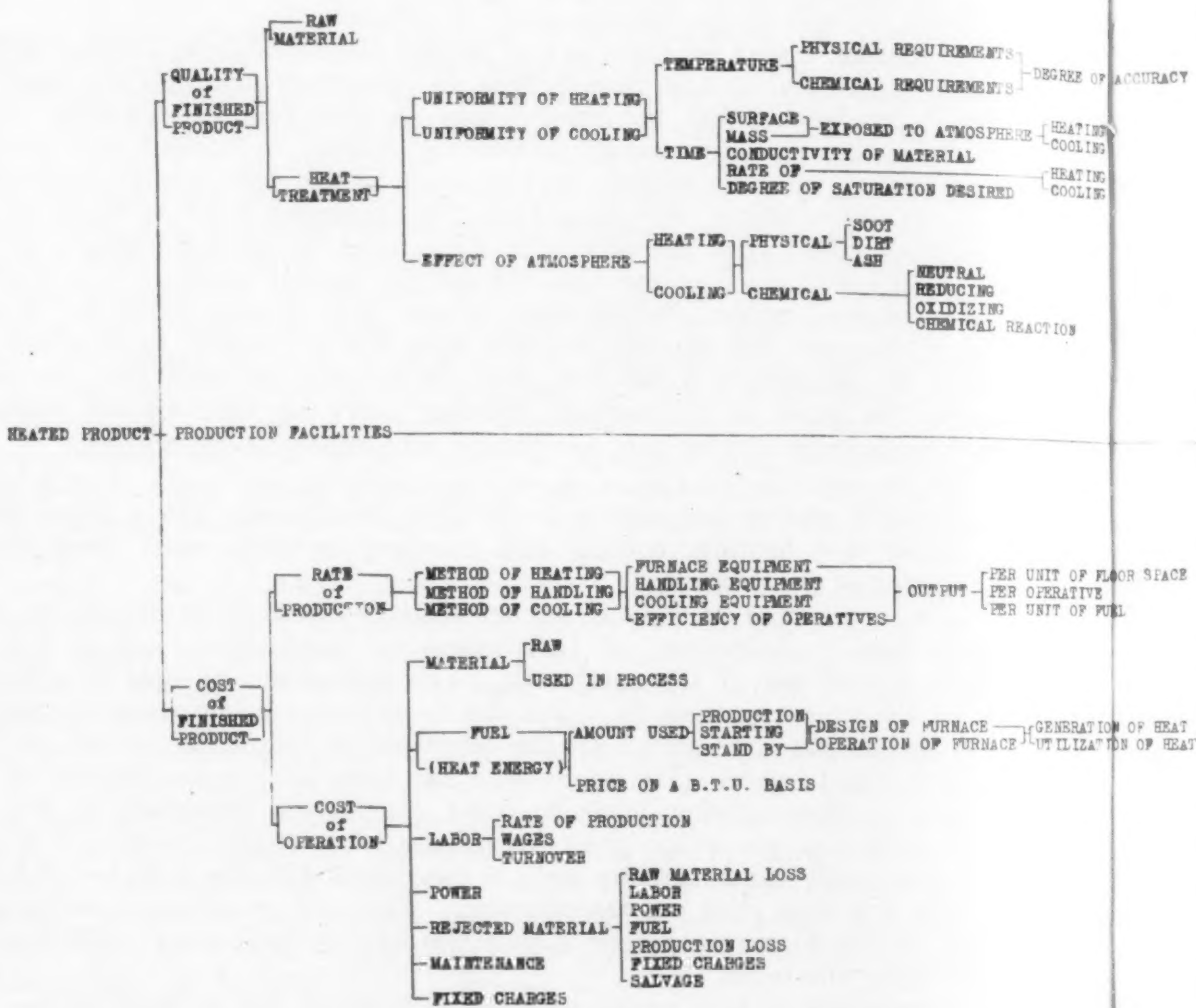
At times it may be necessary to protect the work from contact with the furnace gases and in this case muffles of refractory materials are employed. The atmosphere within the muffle may be oxidizing or reducing, though usually oxidizing. Enameling, glazing and similar operations are conducted in this way. Vitreous enamels may be made in the electric resistance furnace but in the arc furnace, the gases from the electrodes are very liable to have a reducing effect upon the oxides in the enamel. Special atmospheres to control a chemical reaction are obtained by the use of muffles filled with gas or superheated steam. Atmosphere is not due to any particular fuel or type of furnace, but depends entirely upon the air supply for a given fuel. Where the air supply is less than that theoretically required for combustion, so that the gases in the heating chamber carry no free air but contain a small percentage of fuel gas, a reducing atmosphere is maintained.

Production facilities must be provided with regard to the manufacturing requirements and in harmony with the plant conditions. For a given quality of output, the heating, cooling and handling methods must meet the requirements of the process.

The application of heat is not an abstract question or one to be determined from a discussion of fuel values or combustion, nor is the heat balance a real test of the equipment. The application of heat is essentially one of dynamics for heat flow and the thermal condition around a mass to be heated is not determined by the temperature indication at one or more points in the furnace. The stress that has been laid on uniformity of temperature in the chamber leads to false conclusions inasmuch as the temperature at any particular point represents what might be termed a static condition, while fundamentally we are concerned with the transfer of energy and not the indication of temperature. The real condition governing the design of the heating chamber is that the heat be uniformly applied to and absorbed by the work.

Absorption of heat varies with the position of the material in the heating chamber, the location of the combustion chamber in relation to the heating chamber, or, in electric furnaces, to the position of the heating element in relation to the charge. Many electrically-heated furnaces, particularly those of the semi-arc or resistance type, function in the same way as a fuel-fired furnace. The product or material in the furnace is heated by conduction and radiation. The electric energy is used to heat the resistor, which in turn transmits the heat to the product by the atmosphere or by radiation. The laws governing the movement of the gases in the heating chamber are the same with either form of energy. With electricity as with fuels, the uniformity of heat throughout the chamber and uniform heating in the chamber do not necessarily go together, as the result is a function of design and operation and not something inherent in the energy itself. It may be said, however, that electric energy in some form of special equipment can accomplish results not possible with any form of fuel-fired furnace.

In one sense there is no absolute uniformity in the temperature of the gases in the heating chamber. From the time combustion is completed and



FACTORS GOVERNING PRODUCTION
of
HEATED PRODUCTS.

- HEATING
  - APPLICATION OF HEAT
    - THERMAL UNIFORMITY OF HEATING ZONE
    - DESIGN OF HEATING CHAMBER
      - THERMAL
      - STRUCTURAL
    - POSITION OF
      - MATERIAL IN HEATING CHAMBER
      - COMBUSTION CHAMBER
      - INLET AND OUTLET PORTS
      - HEATING ELEMENTS
        - ARC
        - RESISTOR
        - INDUCTOR
  - TEMPERATURE
    - REQUIRED IN PROCESS
    - UNIFORMITY DESIRED
  - TIME
    - SURFACE / MASS — EXPOSED TO ATMOSPHERE
      - HEATING
      - COOLING
    - CONDUCTIVITY OF MATERIAL
    - RATE OF HEATING OR COOLING
    - DEGREE OF SATURATION DESIRED
    - RATE OF CIRCULATION
      - HEATING / COOLING — MEDIUM
        - GASEOUS
        - LIQUID
  - ATMOSPHERE
    - NEUTRAL
    - REDUCING
    - OXIDIZING
    - CHEMICAL REACTION
- COOLING
  - APPLICATION OF COOLING MEDIUM
    - THERMAL UNIFORMITY OF COOLING ZONE
    - DESIGN OF COOLING EQUIPMENT
      - THERMAL
      - STRUCTURAL
    - POSITION OF MATERIAL IN COOLING ZONE
- HANDLING
  - RAW MATERIAL / PROCESS MATERIAL / FINISHED MATERIAL / WASTE MATERIAL
    - IN FURNACE
      - CHARGING
      - DRAWING
    - IN PLANT (Shop Transport)
      - CONTINUOUS / INTERMITTENT
        - DIRECTION OF FLOW
        - RATE OF FLOW
  - EFFICIENCY OF OPERATIVES
- PLANT CONDITIONS
  - LOCATION OF PLANT
    - SPACE AVAILABLE
    - TRANSPORTATION FACILITIES
      - RAIL
      - WATER
      - TRUCK
    - NEIGHBORHOOD
  - CYCLE OF OPERATION
    - CONTINUOUS / INTERMITTENT
      - DAILY / SEASONAL — HOURS OF OPERATION PER DAY
  - LAYOUT OF FURNACES IN SHOP
    - RELATION TO FLOW OF MATERIAL THROUGH PLANT
    - RELATION TO PLANT STRUCTURE
    - RELATION TO SOURCE OF FUEL OR ENERGY SUPPLY
  - FLOOR SPACE / HEAD ROOM
    - FURNACES AND ACCESSORIES
    - HANDLING / STORAGE
      - MATERIAL
        - RAW
        - IN PROCESS
        - FINISHED
        - WASTE
      - FUEL
    - AUXILIARY EQUIPMENT
  - AVAILABLE SOURCES OF HEAT ENERGY
    - ELECTRIC / FUEL
      - FORM
        - PHYSICAL
        - CHEMICAL
      - PRICE
  - POWER AVAILABLE
    - ELECTRIC
      - ALTERNATING CURRENT
      - DIRECT CURRENT
    - STEAM
    - AIR
    - HYDRAULIC
  - HUMAN ELEMENT
    - INTELLIGENCE
    - SKILL
    - MORALE
  - WORKING CONDITIONS
    - COMFORT OF OPERATIVES
    - HEAT
    - LIGHT
    - CLEANLINESS
    - VENTILATION
    - SANITARY CONDITIONS
  - MAINTENANCE FACILITIES
  - NEIGHBORHOOD INFLUENCE
    - INTERNAL / EXTERNAL
      - FUMES
      - SMOKE
      - DUST
      - DIRT
      - NOISE
      - HEAT
  - LEGAL RESTRICTIONS
  - SHUT DOWN HAZARD
    - ACCIDENT HAZARD
    - FIRE HAZARD
    - FAILURE OF ENERGY SUPPLY
  - INVESTMENT IN
    - FURNACES AND AUXILIARY EQUIPMENT
    - HANDLING FACILITIES
    - STORAGE FACILITIES
    - MATERIAL IN STORAGE
    - — POTENTIAL EARNING CAPACITY
  - FIXED CHARGES ON
    - FLOOR SPACE
    - EQUIPMENT
    - MATERIAL
      - RAW
      - PROCESS

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until the gases leave the heating chamber, they are giving up heat, and at the same time, decreasing in temperature. This condition determines the position and design of inlet and outlet ports. Hot gases rise and must therefore be pulled down; cold gases fall and must therefore be pushed up. The high velocity of gases, due to a temperature difference, is not generally appreciated. It is evident that the heating conditions, when the chamber is empty, are very different from those existing when the chamber is full. In many cases the chamber is so overloaded that the flow of heat becomes essentially that through a series of flues, and consequently the placing of the charge should follow the fundamental requirement that a hot gas when cooling should go down; a cold gas when heating should go up, and this condition of flow be fixed by the location of the ports.

Most malleable iron annealing furnaces are packed too solidly and often times the rejections would be materially reduced by the use of a smaller charge placed with more open space between the saggers. In some periodic kiln operations, a virtue is made of necessity, due to improper application of heat, for instance, abrasive wheels are graded by their degree of burn due to their position in the kiln. The same defect in placing the charge is often observed in carbonizing furnaces and is aggravated by the relatively short time required for the carbonizing operation. There is no excuse for this practice in open chamber heating and from a pile of pieces in one charge; it is often possible to pick out two or three distinct degrees of heat.

The same considerations that govern absorption of heat by the work apply with equal force to the cooling or quenching of the work. Where the work is cooled by quenching the action may be much more drastic in its effect on the steel and therefore requires more refinement in the details of handling. Heat gives the structure, cooling fixes it. Heating should be slow and may be prolonged with less injury than where the heating is too fast. There is not the same flexibility in the cooling operation which must be performed with more precision in point of time. Heating and cooling may be more or less automatic through the mechanical handling of the work, and the same consideration of the effect of surface and mass upon the time and temperature should be given to the cooling or quenching process that is given to the heating.

As the size of the work increases, the difficulties of heat treating largely are those of handling the material. The mechanical handling of hot material gives rise to quite a different set of conditions to those met in handling cold material. Each definite range of temperature requires the development of a satisfactory method of handling. The methods of handling molten steel have been practically standardized for each particular process. The making of brass castings follows a common procedure. There are no standard methods in handling a heat treated product as each instance must be dealt with on the basis of fuel and furnace adapted to the work. In many ways, the difficulties of handling the work are lessened when the transfer is made on a horizontal plane with little or no change in the working level during the operation. Furnaces used in connection with sheet rolling mills often have the hearth line at the same height as the roll. Forge furnaces have their hearth line at the level of the hammer or press dies.

Plant conditions not only affect the quality of the output but may materially affect the cost of a finished product and should be considered in detail as part of the production facilities.

In the location of a plant the cost of land is seldom a determining factor. Contour may be taken advantage of for certain operations. Level ground or hillside may have particular features desired for certain processes. A difference in elevation may permit the conveying of material by gravity or aid the disposal of waste. Low undrained spots may be used as a dump for waste material.

The space available fixes the type of construction and may lead to a one-story building or to a concentration in a high story building. In a high story building the flow of product may be vertical, from top down, instead of horizontal. In the manufacture of many lines of small metal parts material received at the ground floor is raised to the upper floor and then progressively descends while being processed until it is finally packed for shipment at the same level on which it was received.

Transportation is of importance and vitally so at the present time. While freight rates on different classes of commodities have a marked influence, there must be a general balance between raw material and the market for the finished product, with power, fuel and other items shifting the fulcrum of this balance. Nearness to source of raw material and nearness to final markets should be considered. Nearness to special labor markets have settled special trades in certain localities, for instance, the brass industry in the Naugatuck Valley. Fuel or power may be determining factors as the cheap power development at Niagara, cheap fuel at Pittsburgh, and water power in New England. In general, rail transportation is preferred to water for nearly all purposes, as the latter is often inoperative for part of the year.

The general tendency is for a small plant to locate in a city or suburbs. In a large city, while the labor supply may be plentiful, it is apt to be inferior in quality and unsteady. At the same time such location usually offers the advantages of fire and police protection, water supply and sewerage. A location between two near cities is affected by the high labor turnover due to the general floating or drifting of labor from one city to the other. In general the tendency as the size of the plant increases is away from the city leading, in some cases, to an isolated industrial community.

The cycle of manufacturing operations may require that two or more departments be adjacent or in definite relation to each other, or it may require one or more passages of the work through one of the departments, as an annealing operation following successive machine operations. Layout requirements should, as far as possible, be in harmony with those conditions tending to reduce fire and accident hazard. Where possible operation should be continuous rather than intermittent and this is determined by the size of the furnace as well as by the process and the temperature required. The operation may be continuous, as that of a blast furnace, or an intermittent operation may be carried on continuously as in the open-hearth furnace or an intermittent operation as malleable iron annealing or burning ceramic ware where the charging, heating and cooling cycle may extend over a period of several days. None of these operations would be practicable on an eight-hour basis with a shutdown at night.

Since the furnace operation is but one in the sequence of the manufacturing operations, it follows that the furnace should be located in its proper point in the order of operations, although in general this sequence is due to the economics of handling rather than the particular geographical

position, and the internal transportation system of a plant determines the relative position. The question of location is usually one of compromise or a balancing of alternatives. Work is brought to and taken from the furnace. Its form may be the same or different as in a melting furnace or a cupola where solid raw material is charged and the charge in a liquid or molten state is transferred to another point.

Fuel is brought to the furnace and, in the case of solid fuel, ash or refuse is removed. Just how far it is desirable to locate the fuel supply in relation to the furnace, depends on the character of the fuel. Fuel oil, from its nature, is readily and cheaply distributed through a plant at small cost for pumps and pipe lines. Gas has similar advantages in distribution. Cold washed producer gas may be piped through a plant as required. Hot producer gas must be used comparatively near the generator. Energy in the form of electric current is very flexibly distributed. With solid fuel the cost of handling is large compared with the cost of the fuel. This tends to place the furnace in close proximity to the fuel supply.

In the grouping of furnaces, a single process leads to the simplest and most compact grouping. With several processes underway at the same time, an entirely different arrangement of floor space, different methods of handling and even different fuels may be required. The facilities for handling the fuel may require as much space as the furnace and the auxiliary equipment becomes a large item in the required floor space. An electric heating furnace may require a transformer that takes up more space than the furnace.

In general the sources of heat energy available for industrial purposes are those fuels provided by nature; coal, wood, oil and natural gas, or electric energy from the above fuels or from water power. Coal may be used in its raw state; it may be powdered, which changes its physical form but not its chemical form, or it may be gasified, changing its physical as well as its chemical form. Depending upon the method of gasification, coal is the basis of gases having widely different qualities ranging from producer gas with a low B. t. u. content per cubic foot through various mixtures of coal gas, producer gas or water gas under the general name of fuel gas. Coal gas in general has the highest B.t.u. value per cubic foot while blue water gas, intermediate in value between producer gas and coal gas, gives a higher temperature.

A fuel to be commercially available must have a form, value and price that will permit its use in the particular form most suitable for the purposes desired. The unit cost of gaseous fuel is much greater than that of the solid fuel from which it is obtained but due to its form value, the gaseous form permits a reduction in the net fuel cost per unit of product. Fuel is here considered simply a source of latent heat energy without taking account of its commodity value. The principles governing the application of heat and the factors entering into the result are the same in electric heating as with other fuel, and while the flow of electric energy is readily controlled, it must be realized that this does not imply the same degree of control in the application of the heat produced.

The power available may influence the type of furnace and the method of handling the work through the furnace but in general the question of power concerns principally the operation of auxiliaries and continuous or intermittent demands for power will influence the choice. Electric and

steam power are well adapted to continuous operation. Steam power, due to condensation, is not well adapted to an intermittent demand. Electric, air and hydraulic power are adapted to intermittent operation where the energy may be stored during certain parts of an operating cycle. Electric power is gradually superseding air and hydraulic power in steel mill practice.

In considering the human element, intelligence may be purchased but without skill has potential value only; skill may be required but without intelligence will accomplish indifferent results. Morale must be developed; labor has in a large measure lost that sense of fidelity and loyalty to the ideals of a trade that forms a basis morale. This question must be solved in each plant depending upon the type of organization, the distribution of responsibility and the sequence of authority are large factors in determining the most effective form of co-operation.

Recent and to some extent present conditions show that while the working conditions within the plant may be of the best, if the workman has no suitable place to live, his value as a producer is greatly diminished and the type of workman is directly reflected by his home surroundings. The cheap lodging house or bunk house under unsanitary conditions reduces the type of labor to that of the floater, unskilled, of low intelligence and often a menace morally as well as physically to the community. Sanitary conditions mean health, self-respect and increase in the morale. These conditions have been studied in connection with the "safety first" movement leading to a more technical study of occupational disability.

The following conditions are quite common in connection with furnace installations; high temperatures, humidity, noise, vibration, insufficient illumination, excessively bright or harmful industrial lights, vitiated fume or dust laden air. While heat is fundamentally a part of the subject considered, every effort should be made to lessen its ill effects and to prevent its radiation. To some extent this may be attained by the use of heavy, well-insulated furnace construction, water-cooled or insulated doors, protective shields or screens and a natural circulation of air due to locating the furnaces away from walls and by placing them in the center of the building. Ventilation may be improved by a forced air blast directed from the walls and windows to the center of the building.

In connection with the application of heat in industrial furnaces, maintenance of structure and production requires considerable study. In order to reduce the shutdown or time that an appliance is out of service, it is desirable to use standardized units as far as possible, to keep sufficient spare parts on hand and to use standard material in construction. Simplicity of construction is the first requisite and in furnace work the use of standard brick shapes and the avoidance of special tile should be considered. The value of standardization is not fully appreciated. For instance, a consulting engineer bought for export one each of three different makes of melting furnace.

Fume, smoke, dust, dirt, etc., have a direct injurious effect in causing discomfort to the operator, decreasing the productive ability, and resulting in the general lowering of the resistance to disease. When these elements are ejected outside the plant, the surrounding neighborhood suffers injury. Fume and dust from certain chemical and metallurgical operations, smoke from furnaces or boiler plants, noise from hammer shop, have an injurious effect on the neighborhood and eventually affect its character, sometimes

leading to a warefare in which the neighborhood or industry is a victim, the neighborhood is lowered in character or the plant moves.

Some of the conditions outlined above are controlled by restrictions. These restrictions may be legal as by municipal ordinance, state or federal enactment; or the result of a mutual contractural relationship as that with insurance companies; or the restrictions may be moral as imposed by the general civic sense or industrial conscience. Legal restrictions are most direct in their deterrent effect providing, as they do, a penalty for non-observance, at the same time they are very apt to be below the actual needs as indicated by public policy.

Accident and fire hazards may be minimized by the observance of accepted principles of safety engineering and may be covered in part by insurance governing the hazard peculiar to the use of certain forms of heat energy, such as the method of storage, the quantity stored, method of handling, and the way in which it is used. One of the older principles of fire protection was that fires cannot be prevented but they can be controlled and stopped; the newer idea is not only fire protection but more insistently fire prevention.

Failure of energy supply apart from accident, is due largely to transportation troubles and to labor troubles which may interrupt either production or transportation. Such interruption may be reasonably guarded against by providing proper storage. In some cases the user must provide for these contingencies while in others the producer does so by providing local storage. The exhaustion of one source of fuel may require a change to another fuel, or conservation may demand a seasonal distribution or restriction in favor of certain classes of users, as with the natural gas supply in Pittsburgh.

As furnace operations differ widely in the fuel used and in the method of utilizing it, the capital cost or investment in any proposed combination of furnace and fuel should be carefully estimated as it may be found that the cost of furnaces with their auxiliary equipment and handling devices and the cost of fuel storage for any particular fuel does not give the return in earning capacity that another combination of equipment and fuel would give, or when the same floor space is devoted to productive use and the heat energy purchased. The amount of capital which may be tied up in this manner and the real estate occupied as well as the cost of operating a fuel storage plant, not only affects the cost of the fuel used but must be balanced against the potential possibility of utilizing the land and capital as well as a corresponding amount of expense in productive operations. In the same way the fixed charges on floor space, equipment and material must be considered in connection with the investment required and balanced against the potential earning capacity of a different combination of these items.

With a given quality of product and given production facilities, the cost of the finished product will result from the rate of production and the cost of operation. The rate of production will depend upon the output and the hours of operation per day or other unit of time. Output and rate of production will govern the selection of a furnace equipment, the method of heating, the method of handling and the method of cooling. These in turn are influenced by the efficiency of the operatives. There are no fixed standards to determine definitely the form of equipment or fuel to use.

Both must be selected with regard to the manufacturing requirements and the plant conditions. Fuel and equipment should be selected for what it can do under specific conditions.

Output per unit of floor space per operative or per unit of fuel are definite checks on the manufacturing conditions. Cost per unit of fuel or per unit of output is not determinative, and the real question is: What does it cost to do things?, which in this case is to produce a quality product at minimum cost. The cost of operation will depend not only on the cost of the raw material but should include that incidental to the process. The manufacturer does not control the price of fuel but he can to a great extent control the quantity used by the selection of a furnace and fuel adapted to his individual plant conditions. The amount of fuel used will depend on the design of furnace, nature of the operation, and the operation of the furnace. The design of the furnace has its greatest influence on the amount of fuel used in production while the nature of the operation largely influences the amount of fuel used in starting and stand-by operation.

In considering the fuel cost too much emphasis has been laid on the heat value of the fuel, its combustion and the generation of heat, and too little attention has been given to its proper utilization. Many absurd comparisons are made between different fuels, based merely on their heat content, but it should be noted that while a change in the form of energy increases the unit cost of the energy it does not necessarily increase the cost of the ultimate result sought. The ultimate cost is largely influenced by the method of utilizing the energy in its new form.

To reduce labor costs means necessarily increasing the productiveness of the worker. High wages may or may not tend to reduce labor cost; reduction of working hours may or may not reduce labor cost. Labor turnover is influenced largely by the location of the plant.

The use of power is usually considered as an expense. The power required in industrial heating operations is for the most part used in driving the auxiliaries and in handling the work to and from the furnace. Where furnaces are operated with the air for combustion applied by a power-driven unit, the cost of the power is often regarded as an unnecessary expense when compared with stack or natural draft. It will usually be found, however, that the better control of the heating operation both in time and uniform heating conditions, more than justifies the cost of the power used.

This same idea would hold in providing for the generous use of power in the operation of auxiliaries, in the reduction of manual labor and more particularly in handling the quenching medium. In many cases atmospheric cooling of the quenching medium is sufficient to maintain the temperature within the required limits, while in other cases the volume of the output and rate of production requires the installation of a more effective cooling system, which in turn may mean a refrigerating plant. Charging and discharging machines, conveyors and quenching devices represent a justified outlay for power.

Rejected material is not only a direct loss, represented by the raw material, labor, power and fuel costs, but reduces the productive capacity of a plant. Rejected material may be due to defective raw material; sometimes to poor design where the piece is ill-adapted to the treatment proposed, that is while the piece may be treated individually with fair success, by its shape or form it does not lend itself to mass production.

Imperfect heating, due to an overloaded furnace or to improper preliminary or previous treatment, is a common cause for rejected material. The barbarities of the forge shop sometimes render the after treatment distinctively a salvaging operation rather than a normal processing one. Socalled "hospital operations" are costly and the return of salvaged or reprocessed material means only a saving of the cost of the raw material, while all the other items of operating cost are lost and appear twice in the cost of operation. Maintenance charges, apart from a direct item in the cost of operation, should be credited at least as an item of insurance offsetting to a considerable extent the shutdown hazard.

For purposes of distribution, manufacturing costs may be assumed to be made up of material costs, labor costs, and expense, including with expense the item of fixed charges. Material and labor costs may be readily obtained and the nominal cost of operation will be materially affected by the method employed in the distribution of expense. The view is advanced that fixed charges on floor space, equipment and material should be departmentalized and that those items of expense that vary with the output should be segregated and that the cost of the finished product should not be penalized by fixed charges based on the operation of the entire plant.

The foregoing notes outline some of the factors to be considered in the production of a heated product and in essentials may be summarized:

To produce quality product at low cost, it is necessary to select a form of equipment and fuel adapted to the individual plant conditions, which, when properly combined and operated, will produce the results sought.

There are no fixed standards to determine definitely the form of equipment or fuel to use.

Fuel and equipment should be selected for what it can do under specific conditions. The heat unit standard is not a real test of the value of the fuel, nor is the heat balance standard a real test of the value of equipment. Due consideration must be given to the form of fuel and equipment selected for an industrial heating operation and both must be selected with regard to the manufacturing requirements and the plant conditions.

DISCUSSION OF MR. BROWN'S PAPER

MR. LUDWIG: The American Society for Steel Treating as one of the high-class scientific societies in America, I believe, should consider some terms used in heat treatment and furnace constructions more thoroughly than has been done heretofore. I have often heard here in this meeting, and also in technical literature, the terms "reducing" and "oxidizing" atmosphere, or "reducing" and "oxidizing" flame. Now those terms are highly misleading. As some experiments show very clearly there is no such thing as generally reducing or generally oxidizing flame. It is understood that a reducing flame is a flame which has more fuel than necessary for the original amount of air, and oxidizing flame is a flame which has more air than is necessary for the commercial fuel. We call reducing action an action which reduces oxides to metals and consequently we should think that the reducing flame will not reduce the scale on steel. Steel treaters especially use the term "reducing" flame, but what we actually observe is that the socalled reducing flame is actually oxidizing on steel. This observation fully coincides with the chemistry of steel, and the chemistry of oxidation and reduction, so that instead of using terms "oxidizing" and "reducing" flame

would it not be much more scientific, much more to the point, to use the terms "lean" flame and "rich" flame?

CHAIRMAN: Perhaps some of the furnace men can answer this question. I believe that a great deal of our general practice hinges around some of these words that may not be technically correct, but it is up to the furnace men, I would say, to change our understanding if there is to be a change along this line.

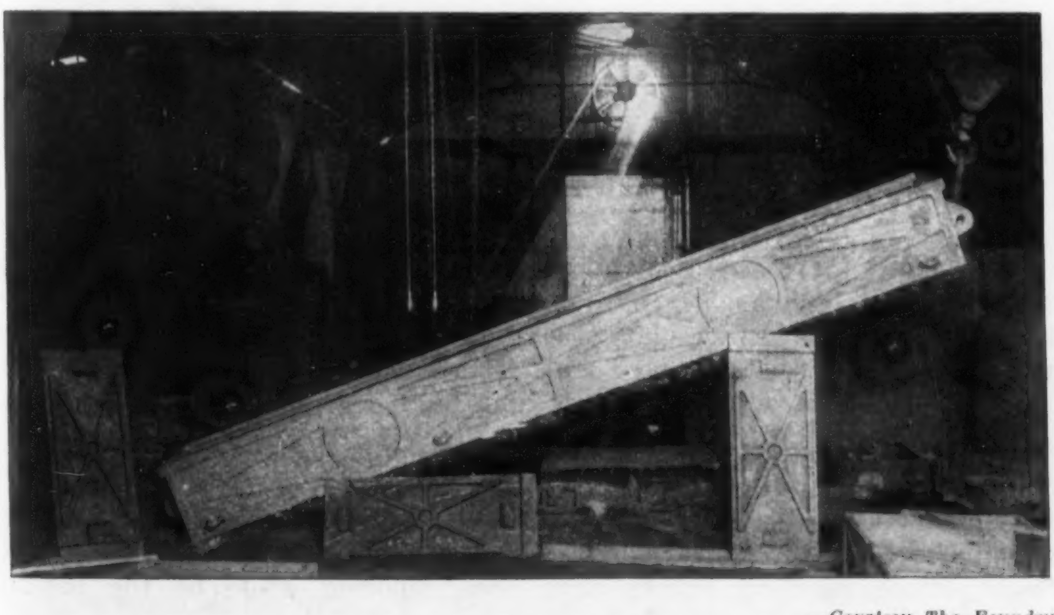
MR. BROWN: Of course the purpose I had in mind was simply to use the terms perhaps in their ordinary sense. That is, the paper, in itself, covered the subject of heating a little more broadly than would be desirable from your particular point of view. For instance, in open-hearth practice there is a definite oxidizing action, and I would rather, of course, hear some other gentlemen give their views as to the proper use of those terms, in other words, not to bring it down to simply a question of terminology but to develop a term or decide what a certain action in handling a furnace does to the metal. That is, do we injure the metal or do we protect the metal? That is really the point desired to impress.

MAKING ALLOY ANNEALING BOXES IN ENGLAND

(Reprinted by permission of The Foundry)

A considerable industry has been built up in Great Britain for the manufacture of chrome-nickel alloy castings. This industry centers in Sheffield, the alloy being chiefly used for the manufacture of annealing boxes, pots, tubes, retorts, etc., used in connection with the heat treatment of high-speed steel. Chrome-nickel alloy castings are being made for these purposes up to 2½ tons in weight. This alloy is said to have special fire resisting and corrosion resisting characteristics.

One of the leading manufacturers of chrome-nickel alloy castings is Kent Smith, Ltd., Sheffield. The accompanying illustration shows an annealing box made of chrome-nickel alloy in the Kent Smith foundry. This box is used for heat treating mill lengths of high speed steel. The



—Courtesy The Foundry

CAST CHROME-NICKEL ANNEALING BOX WEIGHING OVER TWO TONS

casting is 16½ feet long and weighs 4750 pounds. The castings are molded in sand in the ordinary way, and the chrome-nickel alloy is melted in furnaces similar in a general way, to those used for nonferrous metals.

HEAT TREATED STEEL CASTINGS OF CHROME-MOLYBDENUM STEEL

Some experiments recently made in the production of chrome-molybdenum alloy steel castings by the Michigan Steel Castings Co., Detroit, afforded interesting results according to *The Iron Age*. The steel was made in electric furnaces and the castings, which were of various sizes, were subjected to a special heat treatment. The composition was approximately:

	Per Cent		Per Cent
Chromium	1.00	Carbon	0.27
Molybdenum	0.50	Manganese	0.94

The heat treatment to which the castings were submitted was as follows: Annealing at 1650 degrees Fahr. and held for 2 hours at 1575 degrees Fahr., then quenching and drawing at the different temperatures shown in the table of results.

The physical tests of the test pieces taken from the castings after heat treatment were as follows:

Drawn at Degrees Fahr.	Elastic Limit Pounds per square inch	Tensile Strength Pounds per square inch	Elongation Per cent	Reduction of area Per Cent	Elastic Ratio Per cent
1050	132,800	141,520	8.0	30.8	93.4
	141,500	153,900	10.5	28.7	91.9
1150	107,440	124,880	18.0	47.9	86.0
	115,600	131,800	14.0	37.3	87.6
1250	81,520	104,000	20.0	50.3	78.3
	88,900	110,400	20.0	43.0	80.5
1300	75,900	99,400	22.0	52.7	76.4
	76,400	103,000	18.5	52.8	74.1
1350	66,600	100,000	21.0	54.1	66.6
	65,800	98,900	21.0	51.1	66.5

A feature of these results was the high reduction of area combined with unusually high tensile strength. Still more striking was the range of elastic ratio. The best results were those showing the greatest elongation and reduction of area, combined with a high elastic ratio, obtained when the drawing took place at 1250 degrees and 1300 degrees Fahr.

It is stated by the company that a number of the castings of the above composition and heat treatment were in the form of 3-inch diameter shafts while others were cast in blocks, which were used by a large steel company as hammer blocks. Some of those in shaft form were used as axles in which service excellent results have been reported while of the hammer blocks equally satisfactory results were recorded.

THE VALUE OF MOLYBDENUM ALLOY STEELS

By Dr. G. W. Sargent*

(A Paper Presented Before the Detroit Chapter)

Although the author has used the word molybdenum for years, every-time he pronounces it, he thinks of the slang expression "you said a mouthful" and sympathizes with those who utter it for the first time. It is unfortunate that the element does not have a more readily pronounced name. Not so long ago, the writer received from Major D. Bashford, dean of the Metropolitan Museum of Art, New York City, a copy of "Helmet and Body Armor in Modern Warfare" and in looking through it, noticed the following foot note: "As this is written I learn from my friend, Dr. M. Mayajima of Tokyo, this interesting point, which he in turn had from the metallurgist, Dr. D. Kochi of the Faculty of Technology of the Imperial University of Tokyo. It appears that years ago a German steel expert analyzed a part of a sword blade made by the famous Japanese artist, Masamune (1330) and he discovered the rare element molybdenum, doubtless as an impurity, in a certain proportion. This lead the discoverer to determine the local source of Masamune's alloy iron; thereupon he purchased this iron in large lots, much to the surprise of the Japanese who later, when they analyzed captured German cannon decided where a part at least of the molybdenum ore was obtained."

*President, Molybdenum Corp. of America, Pittsburgh.

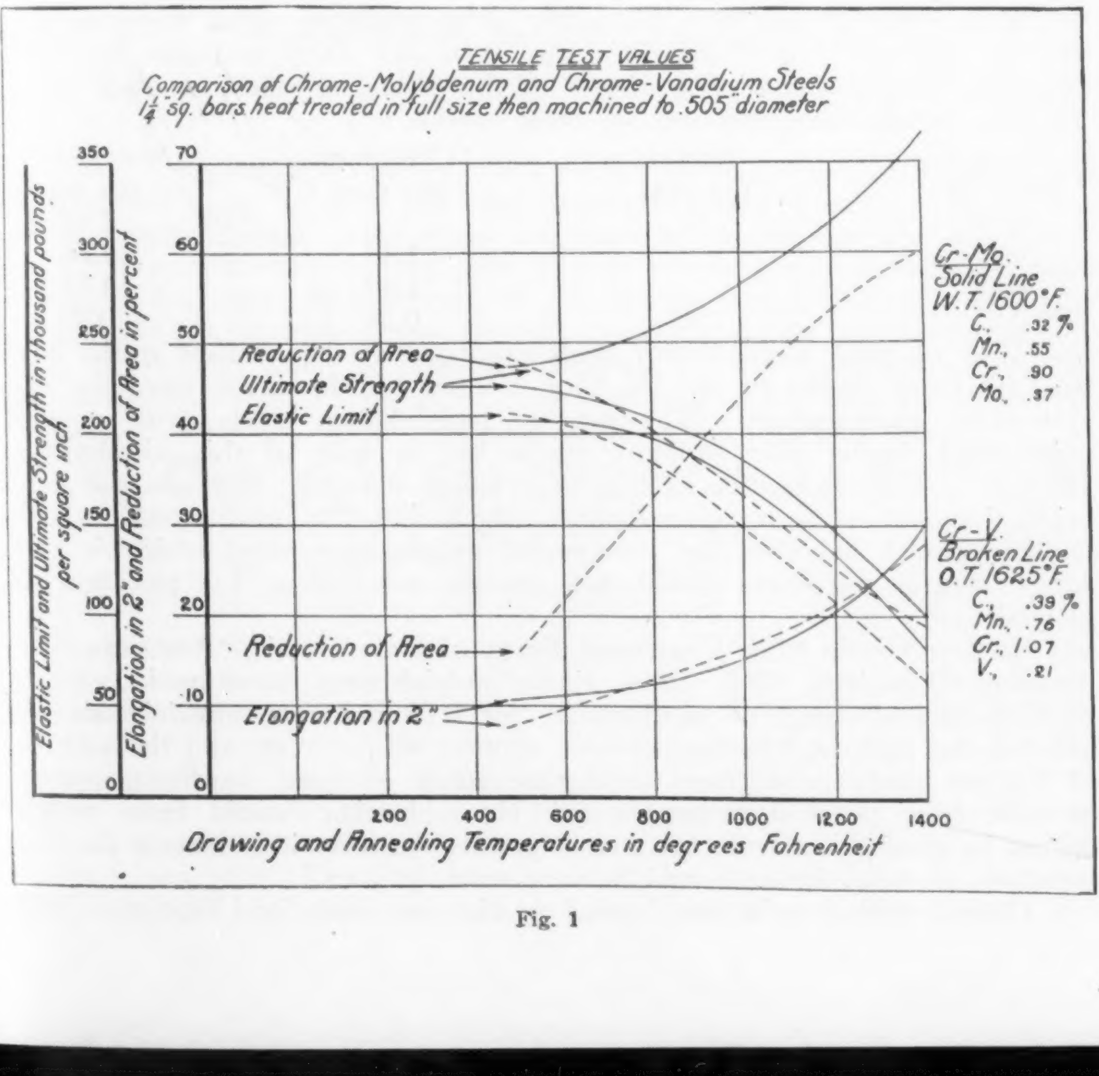


Fig. 1

So it seems that as early as 1330 this element was used in combination with iron.

My own work with molybdenum began in 1890 and in 1894 an article was published on an attempt to produce a theoretically possible molybdenum haloid. In 1899 the first heat of molybdenum steel was made and since then the writer has worked on the various combinations of this element in steels and methods for its estimation.

In 1894 Thomas Blair stated that 1 per cent molybdenum rendered good iron worthless. Dr. Mathews in 1902 contradicted this, but said he found 2.97 to 2.99 per cent molybdenum in steel made it red short. In 1897 Von Lipin states he found 3.72 per cent molybdenum steel hammered better than one containing 3.80 per cent tungsten; furthermore, the former was tougher. Then in 1896 the Creusot works of Schneider et Cie in France set forth that 0.20 to 0.30 per cent molybdenum in 0.20 to 3.00 per cent chromium armor plate steels rendered them less brittle and harder. This was probably the first instance of the use of the chrome-molybdenum combination for the production of tougher steels. Brierly and Ibbotson in 1902 state that experimenters are by no means unanimous with respect to the influence of molybdenum on the mechanical properties of steel, and according to their investigations of the commercial molybdenum alloys available, "it would be surprising if they were." Here then is the explanation of the contrary reports, and with it the author agrees since his own experience with the ferromolybdenum available in the earlier days confirms this.

Between 1902 and 1904, a number of molybdenum steels were made at the Creusot works in France and the *Iron and Steel* magazine for 1904 gives the heating and cooling curves of the following steels as made by E. Saladin, metallurgical engineer of these works:

Carbon per cent	Nickel per cent	Chromium per cent	Molybdenum per cent
0.28	...	...	1.83
0.11	...	1.48	1.66
0.89	...	1.48	1.53
0.21	2.83	0.58	0.80

Most of these molybdenum steels produced at the Creusot works were used by Leon Guillet of the De Dion Bouton Cie for what were the first systematic investigations. The pearlite molybdenum steels show a yield point much higher than ordinary steels, but in spite of this, Guillet says "they have high elongation and good twisting strength, they are not more brittle than carbon steels, but are perceptibly harder." In other words, in 1904 Guillet pointed out that the commercial molybdenum steel which is used for structural purposes should not contain more than 1.0 per cent of molybdenum.

Gustave Gin in "The Electrometallurgy of Rare Metals," American Electrochemical Society, 1907, states that "molybdenum increases largely the ductility and elasticity of hard steels, for 0.25 per cent molybdenum will increase the extension to the point of rupture 40 per cent, and the addition of 1.0 per cent molybdenum to chrome steels of great hardness, permits of their being worked rather easily." He adds that "could ferro molybdenum be obtained at less cost and in greater quantity it is certain the consumption of molybdenum would be very much greater."

Thomas Swinden, in the *Journal of the Iron and Steel Institute,* 1911,

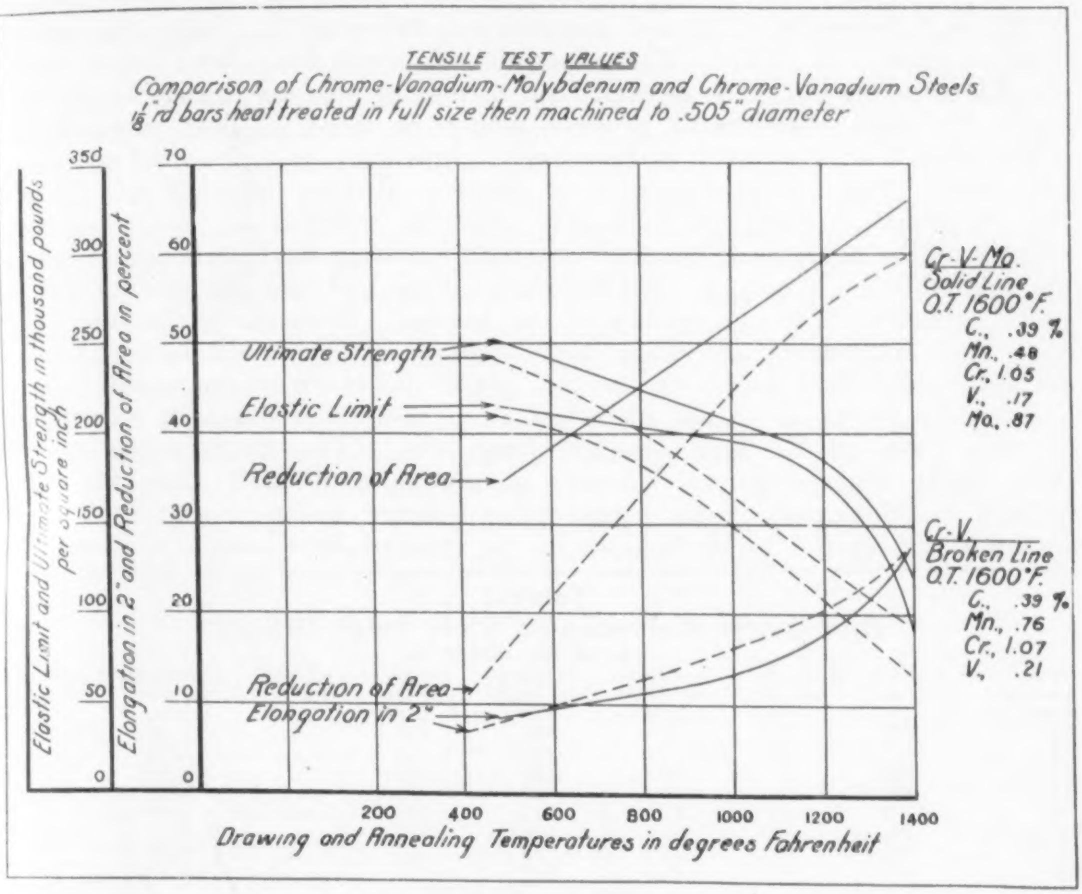


Fig. 2

Carnegie Scholarship Memoirs, Vol. III, investigated four series of molybdenum steels up to 8 per cent content and concludes that the 1 to 2 per cent molybdenum steels show the most interesting physical properties and 1.0 per cent molybdenum gave a most excellent case hardening steel. In making his steels, he recovered 90 per cent of the molybdenum added to the crucible charge and 90 per cent of his ingot weight in finished sound bars. His further study of some molybdenum in alloy steels made in 1913, and published in the *Journal of the Iron and Steel Institute, Carnegie Scholarship Memoirs*, Vol. V. included steels of the following analysis:

No.	Carbon Per cent	Manganese per cent	Silicon per cent	Sulphur per cent	Phosphorus per cent	Molybdenum per cent	Nickel per cent	Chromium per cent	Vanadium per cent
19......	.15	.22	.058	.020	.019	.53	.098	...	...
20......	.19	.23	.056	.023	.020	.53	...	.95	...
21......	.30	.33	.067	.022	.017	.52	...	...	.21
22......	.33	.28	.075	.023	.021	.96	...	...	...
23......	.30	.24	.075	.021	.018	.45	.99	...	...
24......	.32	.28	.082	.021	.019	.46	...	.91	...

Swinden stated: "In the author's previous report several interesting results in mechanical tests were obtained, which gave promise of value as medium tensile steels with good ductility, and a series of mild steels containing molybdenum and other alloys have been prepared and tested." Referring to the tensile test values obtained from these steels after heat treating them, he said: "Steel No. 24 gives promise of being a useful steel of cheaper quality than the high tonnage nickel-chrome steels now on the market which give 110 to 120 tons tensile strength with 10 to 12 per cent elongation. All the steels have notably high reduction of area figures and

in this way resemble nickel and chromium-nickel steels." Under the heading "manufacture," he writes "The experimental ingots have been made by the crucible process, but it is assured that in making any of the steels commercially, the acid open-hearth process would be used." That molybdenum, when alloyed with straight carbon steels, chromium, nickel, nickel-chromium and other alloy steels, imparted to them a further increase of strength and toughness, making of them very desirable commercial steels, has been recognized for years past, but their adoption has been held back on account of the relatively high cost of molybdenum alloys and the uncertainty of the supply, together with the quality of the former. These latter features have now been eliminated, and these molybdenum steels should be even more generally used than nickel or the low grade nickel-chromium steels.

A few words as to the manufacture of these molybdenum steels, then we will pass on to their physical properties. The manufacture of the alloy steels containing molybdenum is no more difficult than the same without molybdenum; in fact, general experience indicates that the molybdenum increases the yield from ingots to shipped bars with less losses due

Table I
Analysis of Molybdenum Steel Ingot Drillings

Number specimen	Carbon per cent	Manganese per cent	Phosphorus per cent	Sulphur per cent	Silicon per cent	Nickel per cent	Chromium per cent	Molybdenum per cent
Ingot No. 192724 Bl								
Heat	.390	.53	.031	.026	.218	.18	1.02	.35
M1	.380	.51	.031	.023	.235	...	1.00	.37
M2	.398	.48	.031	.026	.210	...	1.04	.34
M3	.426	.47	.035	.028	.204	...	1.06	.38
M4	.420	.53	.032	.027	.215	...	1.05	.37
B1	.368	.50	.030	.021	.206	...	1.02	.39
B2	.390	.43	.031	.020	.240	...	1.04	.34
B3	.380	.51	.030	.023	.240	...	1.02	.37
B4	.350	.47	.026	.023	.235	...	1.00	.34
Ingot No. 192734 Bl								
Heat	.400	.45	.044	.033	.204	1.61	.08	.43
M1	.398	.46	.035	.032	.195	1.68	...	.44
M2	.394	.46	.035	.037	.197	1.70	...	.47
M3	.402	.46	.038	.042	.198	1.70	...	.48
M4	.442	.47	.042	.046	.184	1.70	...	.48
B1	.374	.46	.033	.023	.179	1.68	...	.45
B2	.364	.46	.033	.031	.190	1.64	...	.44
B3	.312	.44	.031	.029	.174	1.68	...	.40
B4	.308	.43	.026	.025	.174	1.65	...	.40

* Data obtained through courtesy of R. M.Bird,metallurgist Bethlehem Steel Co. Specimens taken across top and bottom cuts of two 40-inch corrugated ingots.

to seams, pipeage, and discards. These steels may be melted in the crucible, basic or acid open-hearth, and the author believes should it be desirable, in the bessemer converter.

If the crucible process is employed, the ferromolybdenum is placed in the crucible with the last two-thirds of the charge, after the practice of making tungsten steels. Molybdenum powder, similar to tungsten powder, may be used, but on account of its high melting point and the impurities usually present, the recovery of molybdenum in the finished steel is less than is the case when ferro with its melting point around 1550 degrees Cent. for 50 to 60 per cent molybdenum. Molybdenum powder, amorphous metal, melts between 2500 and 2550 degrees Cent. and its uniform diffusion throughout the melt does not always take place. The advisability of using ferro is apparent, and calcium molybdate should never be used in the crucible process. In using the ferro, practically all the molybdenum added to the melt will be recovered in the ingot metal and this is also true of the basic or acid open-hearth practice.

In following the open-hearth practice, the ferromolybdenum is added before the ferrochrome and after the slag has been cleared up, that is to say,

generally freed from oxides by the usual methods. Molybdenum steel scrap may be remelted without loss, or very little at most of the molybdenum. In this respect it behaves like nickel. Some of the types of these molybdenum steels are: Chrome-vanadium-molybdenum; chrome-molybdenum; nickel-molybdenum; nickel-chrome-molybdenum; manganese-molybdenum; silicon-molybdenum; and silico-manganese-molybdenum.

The physical characteristics of some of these steels are shown by the following charts, Figs. 1 to 5 inclusive, a study of which shows their merits. The uniformity of these molybdenum steels is shown by Table I of analyses of four sets of drillings taken across top and bottom cuts of two 40-inch corrugated ingots. These drillings were numbered from the outside towards the center. From this table it is evident that molybdenum does not segregate or cause segregation.

In the comparison charts, it will be observed in the case of the molybdenum steels, that as the drawing temperatures are raised up to 1000 to 1200 degrees Fahr. to further increase the toughness, the decrease in ultimate strength and elastic limit values is less than is the case with the other steel compared. Furthermore, reductions of area which is the best measure of the toughness of the alloy steels is generally greater.

The molybdenum steels as a whole in the rolled or forged condition, show uniformly higher ultimate strength and elastic limits with greater elongation and reduction of area. Data for this is shown as follows:

	Ultimate strength, Lbs. Sq. In.	Elastic limit, Lbs. Sq. In.	Elongation in 2 inches per cent	Reduction of area per cent
No. 1 chromium molybdenum as rolled 1-inch round....	140,000	105,000	15.0	32.0
No. 2 nickel molybdenum as rolled 1 inch round	120,000	93,000	18.0	39.05

Analysis of Specimens

	Carbon per cent	Chromium per cent	Nickel per cent	Molybdenum per cent
No. 1	0.40	1.00	...	.35
No. 2	0.40	...	1.50	.40

The elastic limit of No. 1 as rolled together with its easy machining qualities, for it machines as readily as the 70,000 pound per square inch elastic limit manganese steel used for gun barrels, recommends it for the purpose.

The effect of various quenching temperatures on the tensile test values of the chrome molybdenum steels is shown by the following table and chart:

Quenching temperatures degrees Fahr.	Ultimate strength, pounds per square inch	Elastic limit, pounds per square inch	Elongation per cent in 2 inches	Reduction of area, per cent
1550	160,925	156,625	18.0	62.2
1600	155,850	149,925	17.5	60.2
1650	156,375	145,775	17.0	60.2
1700	153,450	141,570	17.0	60.1
1750	154,350	142,500	18.0	60.0
1800	154,900	144,000	17.5	59.0

Drawing temperature 1000 degrees Fahr. Quenching medium water. ¾-inch round bar used in tests. Analysis: 0.30 per cent carbon; 0.70 per cent chromium; 0.35 per cent molybdenum.

A microscopic study of the structure of most all these steels shows great similarity in that when quenched and drawn from 350 to 1100 degrees Fahr. they reveal a fine uniform distribution of the constituents, so much so, that the structure of the specimen drawn at 1100 degrees Fahr. which presumably contains ferrite and pearlite, but possess a pseudo-martensitic

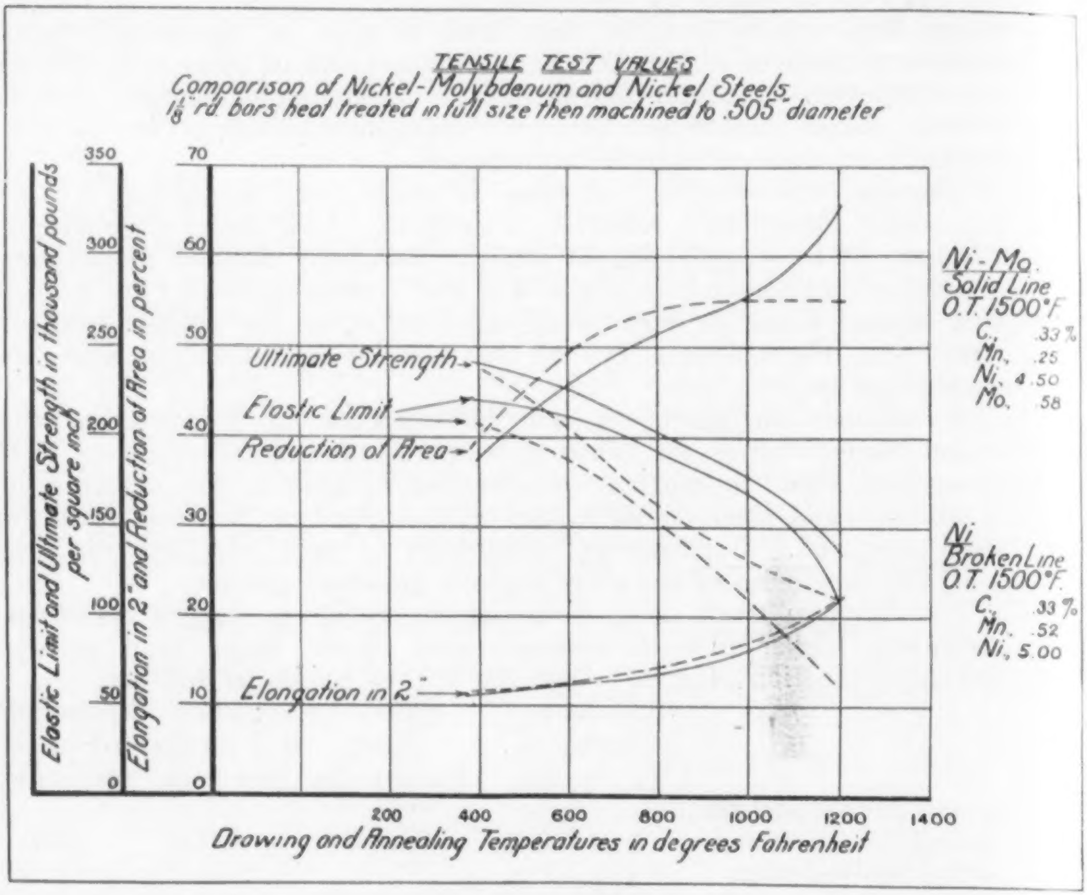


Fig. 3

structure, cannot be readily distinguished from that drawn at 350 degrees Fahr.

Except in the case of lower molybdenum content steels, which show when drawn as high as 700 degrees Fahr. a martensitic, or pseudo-martensitic structure; otherwise even these are alike as the following studies show. When heated after quenching to 1400 degrees Fahr. the ferrite separates out distinctly from the pearlite, which latter takes a more true pearlitic structure. In other words, the steel becomes annealed.

Molybdenum steels are economical not only in their first cost but also to handle through the manufacturing stages. They will save money in machining and they will save money in heat treating, and they forge as readily as carbon steels.

Now, as to the available supply of molybdenum, it is chiefly obtained from the ores molybdenite and wulfenite, MoS_2 and $PbMoO_4$. The former is the most important and most widely distributed. It is stated that Queensland and New South Wales Australia were for many years the largest producers; in 1906 100 tons of MoS_2 were produced. Norway is said to have produced in 1915 87 tons of MoS_2. Canada produced 135 tons of MoS_2. Although the author has no reliable statistics of the production in the United States, he is of the opinion that the year 1918 saw 250 to 300 tons of MoS_2 produced. Of this nearly 200 tons were manufactured into ferromolybdenum by the Electric Reduction Co., Washington, Pa. now the Molybdenum Corp. of America. This molybdenum found its way into light armor plate for tanks, etc. and into Liberty motors.

The recent discovery of large rich deposit of MoS_2 in northern New Mexico and the development of the Colorado mines assure a supply of ore sufficient to meet any demand that may come through the extensive use of the molybdenum alloy steels.

The deposit has been developed during the past year and it is conservatively estimated to contain 60,000,000 pounds of MoS_2 in the group of veins now being worked. This group is located at the southern end of the property. Other and larger groups exist just north and parallel to these. The ore is high grade, easily mined and concentrated, since it is massive and not diffused through the rock as is the case in the Colorado deposits. The ore varies from 1.5 to 29 per cent MoS_2 and the veins vary from a few inches to 30 feet in width. The development in the present working warrants stopping the work for a width of 9 to 30 feet and a height of 600 feet.

Plans for the erection of a power plant on the Rio Grande and a mill capable of producing a million pounds of molybdenum annually have been prepared and work is expected to be started on the ground this spring. The corporation plant at Washington, Pa. is now capable of reducing this quantity of molybdenum to ferromolybdenum sufficient for the manufacture of 125,000 tons of 0.4 per cent molybdenum steel. The design of the mill is such that it can readily be added to and the capacity doubled. The present mill has a capacity of about a ton per day of MoS_2 concentrates.

From the foregoing it will be appreciated readily that there is plenty

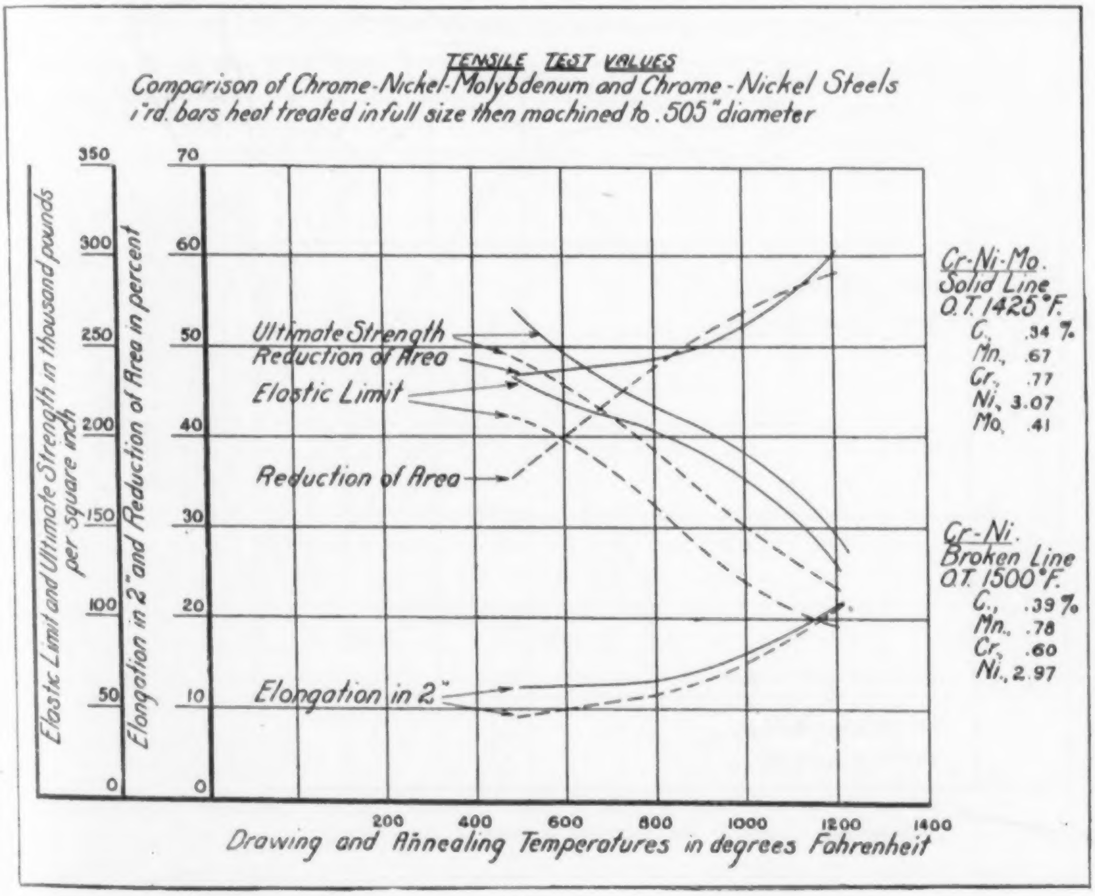


Fig. 4

of molybdenum available to meet the demand as it comes through the greater appreciation of the value of molybdenum alloy steels.

DISCUSSION OF DR. SARGENT'S PAPER

MR. DANSE: Dr. Sargent has stated that this steel is easily machined. I would like to ask that he give us the comparative machinability of chrome-nickel and chrome-vanadium steels.

DR. SARGENT: I cannot give you a comparison in figures, or say that you can turn out so many hundred gears in a certain length of time, but I think there are gentlemen here who can, perhaps. In turning up test pieces, I have noted personally the easy machining of the chrome-molybdenum steel. I have received reports from various factories and from the testing departments that the chrome-molybdenum steel machines as readily as straight carbon steel, and this comes from those who have handled many tons of the steel.

MR. DANSE: The straight carbon steels have a manganese and carbon content specified. Is there a manganese and carbon content specified in the molybdenum steels as in the straight carbon steels?

DR. SARGENT: Yes, as in the other alloy steels.

MR. DANSE: The Ford Motor Co. has done more work with these molybdenum steels than any others that I know of. They take straight carbon in which the molybdenum will be 1.05 per cent, straight nickel with

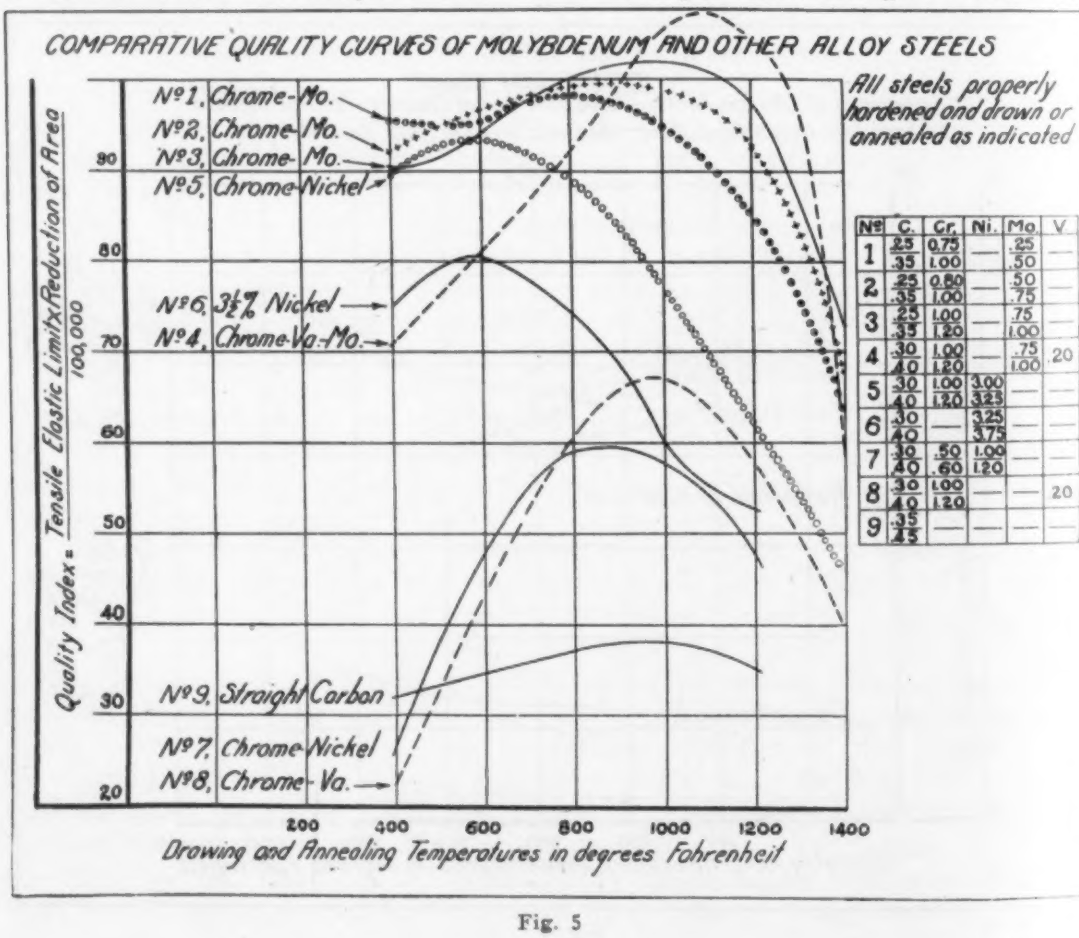


Fig. 5

1.35 per cent molybdenum. I was wondering if you used chrome-molybdenum or straight molybdenum in your machining tests.

DR. SARGENT: It seems that small amounts of molybdenum improve the machining qualities of the alloy steels to which it is added. I think you will find the molybdenum steels somewhat easier to machine.

MR. MADRE: I would like to mention a few troubles we experienced when we started to use molybdenum about three years ago. The first thing was hard forged dies, the analysis of which was: Carbon 0.60; chromium 3.60; vanadium 0.50; and molybdenum 0.35 per cent. We noticed that most of the dies cracked when we put them in oil and left them during hardening. We were inclined to believe that the trouble was due to the molybdenum and consequently the use of molybdenum was stopped. I do not know exactly whether our analyses were off or not. Secondly, we started to use molybdenum in crankshaft steel: Carbon 0.28 to 0.32; chromium 0.90 to 1.10; manganese 0.60 to 0.80; and molybdenum 0.30 to 0.40 per cent. In this analysis, we replaced molybdenum with 0.18 per cent vanadium, and the first thing we found was that the machinability was far less as compared to vanadium steel, and especially that the drilling on some of our bars was hard as compared to vanadium steel. Also, we noted the fact that some of the crankshafts when they were put in the condition of 50 to 60 Shore hardness cracked. Therefore, we gave up the use of molybdenum. I do not know exactly whether it was the use of molybdenum or something else. In the foregoing, manganese was never above 0.50 per cent while in the crankshaft manganese was between 0.60 and 0.80 per cent. From the charts I have noticed that in all these your manganese does not run above 0.50 per cent.

DR. SARGENT: I could not give you a correct answer as to the cause of all your troubles, perhaps, but I would say at once that with 3.5 per cent of chromium in die block steel, you were very very high, obtaining a hard alloy steel. That much chromium is away beyond the commercial range of any chrome steels for this purpose, even in projectile steels. I remember well that we never made a successful projectile in the olden times with more than 3 per cent chromium. We tried to keep it down to 2.75 per cent as a maximum. If we went higher and the shells were in the neighborhood of 0.65 to 0.75 per cent carbon, we had bad losses in their heat treatment. It would be a rather ticklish steel to handle with all the hardening elements you mention as being present in your die block steel.

Now as to the crankshafts breaking, it may be that you had too much carbon with too much manganese for a water hardening steel. The steel for crankshafts does not need to be so high; in fact, I recommend strongly that you keep under 0.30 per cent carbon. You can go to 0.32 or 0.33 per cent carbon, but it is best to keep the carbon down and the manganese within the usual limits, and you can water hardening without any trouble. I think that is probably one answer to your troubles. Your steel might also be segregated due to the methods employed in its manufacture. If we had some of the steel available, we could dig into it and could probably find out more definitely the cause of your troubles and a way to eliminate them.

MR. MADRE: Do you think that 0.32 per cent carbon with 0.45 per cent molybdenum is too strong a combination?

DR. SARGENT: No. With 0.32 per cent carbon and 0.40 per cent molybdenum and 0.70 to 0.80 per cent and sometimes even as high as 1 per cent chromium, you will have no trouble with your crankshafts, provided, of course, that your heat treating and forging practices are not abnormal.

HIGH TEMPERATURE RESISTING ALLOYS FOR CARBONIZING

By A. Bensel*

(A Paper Presented by Title at Philadelphia Convention)

Carbonizing, as will be dealt with in this article, is the process of heating a low carbon steel in intimate contact with carbonaceous material at a temperature just above the upper critical point of the steel for such a period of time as is necessary to produce a carbon penetration of the required depth. It is not necessary to elaborate on this process from a technical standpoint as steel treaters are so well versed on the subject.

Since the object of this article is to set forth the desirability of good heat resisting containers, mention should be made of the standard methods of case hardening which employ these containers. The methods in question are:

1. Pack Carbonizing
2. Liquid Bath Carbonizing
3. Gas Carbonizing

The first method consists in packing the low carbon steel parts to be treated with solid carbonaceous compound in a suitable container and in heating to a temperature just above the upper critical point of the steel for the length of time necessary to obtain the depth of carbon penetration required. This method is used mostly for the larger sized pieces where a large area of surface must be carbonized. The shape of the containers will vary according to the shape of the pieces to be treated, being either rectangular, circular, or circular with a chimney in the center.

Liquid bath carbonizing consists in keeping a fused liquid bath in some suitable container at a temperature above the upper critical range of the steel and then dipping the pieces to be treated into this bath for a short period of time, usually 10 to 12 minutes. This method is used mostly for small pieces and where a very thin case is all that is required. The pieces are placed in some type of dipping basket and in this manner kept under the surface of the bath during the time interval required. A sodium cyanide-sodium chloride mixture is the most widely used material for this liquid bath method.

Gas carbonizing consists in utilizing a gas to furnish the carbon to the steel to be treated on the theory that it is the gas developed by the dissociation by heat of the solid carbonaceous material used in pack hardening that is the active agent. In this method the gas is used directly on the steel without having it formed by dissociation. The equipment for this method usually is a horizontal retort rotating in a combustion chamber fitted with a suitable burner equipment for securing the proper temperature, which as in the previous methods, must be above the upper critical point of the steel pieces. The pieces are put into one end of the retort and are discharged at the opposite end, after the proper time interval. Gas is forced into the retort and as the temperature is correct for carbonizing, the steel absorbs carbon readily.

All three of these methods have their advantageous use dependent upon the work to be done. It is of special importance that a suitable container be selected in each of the three methods. This container must be capable of confining all of the gases, carbonaceous material and liquid to produce uniformly good results, and this capability must not be affected by the temperature to which the container is subjected. The ob-

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ject of this article is to deal especially with the carbonizing containers capable of withstanding high temperature and oxidation for long periods.

It is a well known fact that cast iron and steel carbonizing containers are badly distorted in a relatively short time with the result that it is impossible to load a furnace evenly with these boxes of unequal dimentions. Therefore, we have by the use of high temperature resisting alloy containers the very important advantage of greater furnace capacity resulting in increased production. An important consideration is that of scaling for the clinging scale is an insulator, making the heat penetration poor. When the scale drops off and the walls are consequently thinner, the heat penetration is thereby affected and the work in process either receives too much or too little heat, depending on whether a new or an old container is used.

The containers should be of material not easily carbonized so that the efficiency of the carbonaceous material is not lowered by part of it being utilized to carbonize the container, thus leaving the contents undertreated. They must not be brittle for in service these containers receive rough usage while hot, and brittle containers would crack or break up under the severe treatment. They should be capable of being machined as machining operations are often necessary in order to get a tight fitting cover. They should be made of material which has a high tensile strength and which will retain much of that strength at the usual operating temperatures. The service of these containers should be such that the proportion of service to price makes their cost per hour reasonable.

Until recently all these containers were cast of either iron or steel. They were deficient in practically every one of the requirements above mentioned, especially the one least thought of, namely that of cost price per hour of service rendered. It was evident to every one interested in the process of carbonizing that some alloy would be necessary to meet the requirements; not an alloy steel because it scaled badly, warped and only increased the cost, but a really high grade heat resisting alloy. It has been said that "No one metal is a cure-all", but it would seem that an alloy which would cast successfully, was not so hard that it could not easily be machined, had a high tensile strength which it retained at high temperatures, was not brittle, and above all resisted successfully high temperatures neither scaling nor warping, surely, such an alloy would have cured all the ills that at least carbonizing containers were heir to.

In developing an alloy of this kind it was obvious that to resist high temperatures successfully it would necessarily have to possess a high melting point. Certainly then it would have to be alloyed of metals having high melting points. It was necessary also that these metals alloy themselves homogeneously so that there would be no segregations and the castings would be uniform throughout.

From metallurgical experiences it was evident that whatever this alloy might be, it must necessarily contain chromium in rather large quantities because this element is necessary to prevent scaling at high temperature. This was clearly proved in the work done in developing a suitable metallic electrical resistor. Many alloys could be made that had the proper electrical resistance but in this case, as in the case of carbonizing containers, heat resistance also entered into the problem. For a period of about 14 years no alloy without chromium in large proportion has been found that will resist destructive scaling at temperatures of 1600 to 2000 degrees Fahr.

The alloy then to be successful must contain chromium, but what else? It is well known that nickel and iron alloy perfectly with chromium. We have evidence of this in the homogeneous nickel-chromium steels and also in the nickel-chromium alloys which are used for electrical resistance purposes.

From all past metallurgical experiences, it is safe to say that until some new metal of high melting point is discovered to replace chromium in heat resisting alloys, nickel-chromium alloys will excel for carbonizing containers.

To obtain in regular production the excellent characteristics of this alloy its making must be carefully regulated. The electric arc furnace is best adopted to its melting and the company with which the author is connected has two such furnaces and of 2-ton capacity. Not only is the melting done under the most approved metallurgical conditions, but the molding operations must embody care and attention and methods peculiarly requisite to a metal of large shrinkage and relatively high freezing temperature. The following technical data on the alloy may be of interest. Analysis:

Nickel, 60.0 per cent.
Chromium, 12.0 per cent.
Iron, 26.0 per cent.
Carbon, silicon, manganese, etc., 2.0 per cent.

Melting point, 2660 degrees Fahr.
Safe working temperature, 2000 degrees Fahr.
Specific gravity, 8.15.
Weight per cubic inch, 0.29 pounds.
Specific heat, 0.111 at 100 degrees Cent.
Brinell hardness number, 179.
Sclerescope hardness, 27 to 30.
Coefficient of linear expansion over temperature range from 0 to 100 degrees Cent., 0.0000121.

Thermal conductivity is 0.0341 calories per centimeter per second or a ratio of 1 to 4.88 with soft iron. Expressed in percentage, 20.5 per cent. of the thermal conductivity of soft iron. Tests were made on a 1-inch diameter specimen.

Tensile tests at 70 degrees Fahr.
Elastic limit, 40,000 pounds per square inch.
Ultimate tensile strength, 54,000 pounds per square inch.
Per cent. elongation, 1.00 per cent.
Per cent. reduction of area, 2.50 per cent.

Tensile tests at 1500 degrees Fahr.
Elastic limit, 20,100 pounds per square inch.
Ultimate tensile strength, 24,500 pounds per square inch.
Per cent. elongation, 4.00 per cent.
Per cent. reduction of area, 4.30 per cent.

From a mechanical standpoint it is evident that nickel-chrome steel is good material for castings that must withstand high temperatures as its tensile strength at carbonizing temperatures is so much superior to ferrous materials. This property is directly applicable to carbonizing containers because the wall thickness can be made very light and yet have the required strength, thus increasing heat penetration, reducing length of heat, and thereby effecting proportionate savings of fuel. When cast it will bend at either red or white heat. It does not become easily fatigued.

This fact can be demonstrated by supporting a plate of used cast metal at the four corners and striking the unsupported center with a sledge, thereby bending it.

Attention should be directed to an unique design of carbonizing container which was made possible by the desirable properties of the alloy which allow it to serve for thousands of hours at 1800 degrees Fahr. without cracking or scaling. This design is a round container with a machined taper-fit cover, which fits tightly into the container and effectively closes it as a ground glass stoppered bottle. The machined cover fits the taper of the container as well after several thousand furnace hours as when it was first used and this result in itself shows the absence of warping and scaling.

It should be the consideration of every engineer or metallurgist that his container cost per heat hour be a known fact. This enters directly into production costs and his expense of heat treating manufactured parts cannot be analyzed accurately otherwise. The first cost spread over the active life of the container is the item of interest in the expense of the heat treating department. Protective service guarantees are therefore desirable.

CARBORUNDUM REFRACTORIES IN HEAT TREATING FURNACES

By M. L. Hartman*

(A Paper Presented by Title at Philadelphia Convention)

The use of carborundum refractories in certain parts of heat treating furnaces has given such satisfactory service in cases in which they have been tried, that it seems worth while to discuss briefly the refractory requirements for these furnaces, and to point out the particular value of carborundum refractories in them.

In general, nearly all furnaces for heat treating are so constructed that heat must be conducted through a refractory material from the combustion chamber to the pieces being treated. In order to increase production and also because of the nature of the fuels used, the temperatures reached in the combustion chambers are much higher than those in the treating compartment. In other words, it is decidedly advantageous to have a refractory material of high thermal conductivity separating these two compartments so that heat will be transferred rapidly and economically and the temperatures will be uniform throughout.

On account of the difference in temperature on the two sides of the refractory, resistance to spalling is a property greatly desired. Low coefficient of expansion is also preferred, because the tendency to crack is decreased. Cracks may cause hot spots on the treated pieces, and consequent irregularity of product.

In some cases the refractory pieces are required to carry heavy loads at the high temperature, thus it is quite important that they have great mechanical strength. The plates or tiles also must be supported on piers or checker work which remains rigidly in place, with no softening, slagging or cracking.

Another requirement for the refractory used in the treating floor is that is must resist the action of the scale which comes from the steel under treatment or in some cases from the containers. This especially is

*Director research laboratory, the Carborundum Co., Niagara Falls, N. Y.

important in some classes of work where much scale and high temperatures are encountered.

As stated above the combustion chamber itself is subjected to high temperatures, and in order that the heat be generated regularly and evenly, the firebox linings must not become distorted by cracking or softening of refractories. In oil and gas-fired furnaces the refractories and baffles, which are subjected to the impinging flame, must be of the highest grade material. They must withstand sudden changes of temperature without cracking or spalling and must not become distorted by softening under the high local temperature.

In order to have clearly in mind the distinguishing properties of carborundum refractories, it may be well to state briefly the physical and chemical characteristics of silicon carbide—the primary material in all of them.

Carborundum is a product of the electric furnace and is produced by the chemical reaction between coke and silica sand. This crystalline product, carborundum, or silicon carbide, is not melted at any temperature up to the decomposition point, which is about 4064 degrees Fahr. (2240 degrees Cent.) It conducts heat about seven times as rapidly as fireclay, and better than any other refractory material. The change in volume with change in temperature is almost negligible, and there are no physical transformations at any temperatures below decomposition. Carborundum is quite resistant to chemical action, being inert to nearly all reagents except basic substances at high temperature.

Carborundum refractories, being composed principally of silicon carbides, inherit these desirable properties, and the variation in the properties of the different carborundum products is produced almost entirely by change in the bonding material used. For example, the most refractory of all the carborundum products is the variety which is made entirely of silicon carbides, without any bonding material. This is manufactured by a special process in which the silicon carbide crystals intermesh and interlock to form a rigid body.

This recrystallized material is difficult to produce in any but the most simple shapes, since for many furnaces, such extreme refractibility is not necessary, other carborundum refractories have been developed using the smallest possible amount of bonding material to hold together the silicon carbide particles. Variations in the nature of this bonding material have made possible the production of several kinds of bonded refractories each having the required properties for its particular uses. More or less intricate shapes of these materials may be moulded and kiln fired and the finished products have the refractory properties of carborundum slightly modified by the nature of the bonding agent.

While carborundum shaped refractories were being developed, it became evident that for laying up or patching these high grade bricks and shapes, it was necessary to use raw refractory mixtures of similar composition in order to avoid the fusion, cracking and general undesirability of the common mortars and cements. A complete line of carborundum cements therefore was developed, having variation in properties of bonding material to fit every requirement for laying up new work, patching old installations or moulding up special shapes in place. To illustrate how well these materials have served in heat treating furnaces, a few service reports from our records may be of interest.

A number of heat treating furnaces in a large plant in Rhode Island have been provided with carborundum hearth tiles. These have lasted 28 to 30 weeks of continuous use, whereas clay tiles were replaced every two weeks. These furnaces are used for hardening speed steel cutters, and the operating temperature is around 2300 degrees Fahr. (1260 degrees Cent.)

At a machinery manufacturing plant in New Hampshire, carborundum floor tile, supports and linings have been installed in two large carbonizing furnaces. One of these is fired with hard coal and the other by means of oil and both are operated from 50 to 150 hours per week. Both furnaces have been in operation for condition as when installed. The previous fireclay linings lasted only from four to six weeks. A notable economy in fuel consumption is also apparent. This is estimated by the operation at about 25 per cent saving.

Carborundum floor tile have been adopted for all high speed tool steel hardening furnaces in one of the largest motor car plants in Detroit. This company reported that carborundum was the most satisfactory material it had tried, because it was not affected by changing temperatures, and did not soften and distort under heavy load as did fireclay tiles.

At the two other motor companies in Detroit, carborundum floor tile have been giving long service, and after nine or ten months are still in use. Another Detroit manufacturer of tools has been using carborundum hearth plates at 2450 degrees Fahr. (1340 degrees Cent.) for six to eight months. More uniform heating results from their use. In the same furnaces fireclay hearths failed by cracking and slagging and were replaced every four and five weeks.

Near Chicago, a carborundum slab in an underfired gas furnace for high speed steel lasted from February to November, in the same furnace in which fireclay hearths were replaced every week end. Another operator in this district reported that by sprinkling carborundum grain or dry carborundum cement over his floor slabs each morning he prolonged the life of the refractory plate and kept a smooth clean working surface in his furnace.

Enough has been given in these service records to indicate the particular success which has resulted in the adoption of carborundum refractories in the various heat treating furnaces. While one of the chief objections to the use of carborundum refractories has been its high first cost, it must be pointed out that installation and shut down expenses in many cases greatly exceed the amount paid for the refractory parts. The elimination of extensive repairs more than compensates for the increased first cost. The loss of charges in the furnaces at the time of failure is an important item of expense which is nearly eliminated by the use of refractories which serve so long.

News of the Chapters

NEW HAVEN CHAPTER

At a very interesting dinner meeting of the New Haven section held in the Cafe Mellone on May 28, the following officers were elected for the ensuing year: Chairman, Harry V. Goodwill, superintendent of dies,

IRVING H. COWDREY
Elected Chairman of Boston Chapter

CHARLES M. JOHNSON
Elected Chairman of Pittsburgh Chapter

R. Wallace & Sons Mfg. Co., Wallingford; vice chairman, Major Rupert L. Penny, engineer, 54 West Rock Ave.; secretary-treasurer, Walter G. Aurand, chief chemist, R. Wallace & Sons Mfg. Co., Wallingford; members of executive committee, Clayton L. Phillips, Sargent & Co.; Alvin L. Davis, Scovill Mfg. Co., Waterbury; and Rolland G. Hall, R. Wallace & Sons Mfg. Co., Wallingford, Major A. E. Bellis, Bellis Heat Treating Co., William B. Runk, Robert N. Bassett Co., Shelton, Conn. Chairman Entertainment Committee, William B. Runk; chairman Program Committee, J. W. Black, Geometric Tool Co.; chairman Membership Committee, Walter G. Aurand, R. Wallace Sons Mfg. Co.

An organization meeting of the elected officers and committees was held in the Union League Club, New Haven, June 2, where an informal dinner was enjoyed. After dinner plans were perfected for a membership campaign and it was also decided to hold a shore dinner at Savin Rock on June 24. As this will be the final meeting of the year, the Entertainment and Program Committees are endeavoring to make the meeting a banner one as regards speakers and entertainment.

PHILADELPHIA CHAPTER

About 100 members of the Philadelphia chapter attended the May 27 meeting at the Engineers Club. H. S. Rawdon, physicist of the Bureau of Standards spoke on "Structure and Related Properties of Metals". Mr. Rawdon presented his subject in an interesting and intelligent manner, and the discussion following was very good.

The following officers were elected for the coming year: Chairman,

A. W. F. Green, metallurgist, John Illingworth Steel Co.; vice chairman, H. C. Knerr, metallurgist, Naval Aircraft Factory; secretary-treasurer, A. L. Collins, metallurgist, Ace Motor Corp.; members of executive committee, J. J. Crowe, metallurgist, Philadelphia Navy Yard; D. K. Bullens, Bullens Heat Treating Co.; H. M. Brayton, Frankford Arsenal; Prof. H. Reese, instructor in chemistry, Temple University; J. C. Clark, vice president, E. J. Griffiths Co.

HARTFORD CHAPTER

The annual meeting of the Hartford chapter was held in Jewell Hall of the Y. M. C. A. on June 16. Over 100 were present. The principal speaker of the evening was F. P. Gilligan, secretary-treasurer of the Henry Souther Engineering Co., and nominee for National President of the Society. Mr. Gilligan spoke on the subject of "Steel Research, Its Past and Present". R. K. Newman, secretary of the Frasse Steel Works, also presented a very interesting illustrated paper on the "Fabrication of Steel". The open discussion following the presentation of these papers was very interesting and covered the points brought out by the papers. Consideration was given to the program during the coming year, and discussion was also held with reference to the program for the past year. The new officers for the Hartford chapter are as follows: Chairman, Marcus E. Gere, metallurgist of the New Departure Mfg. Co.; vice chairman, A. H. d'Arcambal, metallurgist of the Pratt & Whitney Co.; secretary-treasurer, James J. Curran, metallurgist of the Henry Souther Engineering Co.; members of the executive committee, D. H. Stacks, C. T. Hewitt, M. E. Blakeslee, L. A. Lanning, C. T. Hathaway, J. J. McIntye.

WASHINGTON CHAPTER

The Washington section of the Society held its June meeting on June 17, in the auditorium of the New Interior Department building, when Enrique Touceda, consulting engineer of the American Malleable Castings Association, gave a talk on the "Manufacture of Malleable Iron Castings". Mr. Touceda covered the complete details of the manufacture of malleable castings and a comparison of their physical properties with that of other ferrous products. Many members of other engineering and technical societies were in attendance, and the meeting was thoroughly enjoyed.

CHICAGO CHAPTER

The June meeting of the Chicago chapter was held on the 16th in the Stevens Building, at 6:30 p. m. There was no principal speaker of the evening, but the meeting was known as "Query Night". The announcement sent out was a form on which the members were requested to write any question or problem pertaining to heat treating which they wished to have answered. They were requested not to sign their names, but to bring the questions and drop them in a box as they entered. A committee of experts, all practical men, was present to discuss thoroughly the questions and problems. This meeting helped to clear up any doubts the members may have had on any phase of the game. The meeting was well attended and proved both profitable and interesting:

SCHENECTADY CHAPTER

The regular meeting of the Schenectady chapter was held Tuesday, June 16, when the speaker of the evening was P. A. E. Armstrong, vice

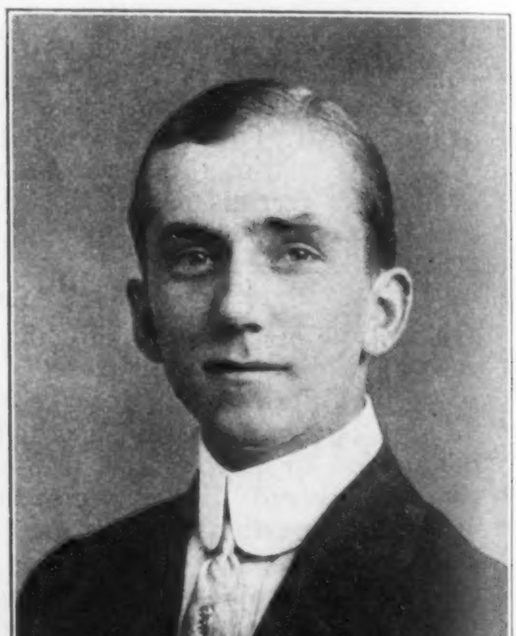
L. A. DANSE
Elected Chairman of Detroit Chapter

W. R. CHAPIN
As Chairman of Indianapolis Executive Committee, He is Directing Plans for the Convention, Sept. 19-24

president of the Ludlum Steel Company. The Schenectady Union Star has the following account of the meeting:

"A meeting of Schenectady Chapter, American Society for Steel Treating, was held last evening in the Civil Engineering building, Union College. P. A. E. Armstrong, vice president of the Ludlum Steel Company, Watervliet, gave a talk on "New Methods for Production of Hollow Drill Steel." He sketched the development of tool steel and mentioned difficulties which had to be overcome. He explained the effect resulting by the addition of tungsten, chromium and vanadium to steel, for tool purposes, and emphasized the importance, when specifying the composition desired, of giving careful consideration to the requirements of actual working conditions to which the tools will be subjected, in service. Following the lecture, many questions were asked Mr. Armstrong, re-

H. C. GOODWILL
Elected Chairman New Haven Chapter



WALTER G. AURAND
Elected Secretary-Treasurer New Haven Chapter

sulting in interesting discussions. As Mr. Armstrong is one of the foremost tool steel experts in the country his remarks were especially interesting and instructive.

"A quartette composed of John Gray, first tenor; Belmont Magill, second tenor; Cyril Cadeau, baritone, and Doc Dillenbeck, basso, rendered several popular selections and received much applause. Chauncey Gray was the accompanist. Mr. Schauffler, Union College, related some very entertaining stories and a motion picture was shown.

"E. J. Edwards, engineer of tests, American Locomotive Company; Carl L. Ipsen, designing engineer, General Electric Company, and G. R. Brophy, metallurgist, General Electric Company, were chosen as delegates for the national convention of the society which takes place in Indianapolis, Ind., next September.

"The Schenectady chapter is planning to have a picnic in August at the Locomotive Club."

NORTH WEST CHAPTER

In addition to the officers of the North West Chapter published in the June issue of TRANSACTIONS, other officers are as follows: Chairman, Prof. Oscar Harder, instructor in metallurgy, University of Minnesota; vice chairman, H. Kenneth Briggs, metallurgist, Minneapolis Electric Steel Castings Co.; secretary-treasurer, Alexis Caswell, secretary of Manufacturers' Club of Minneapolis. The following members of the executive committee were elected: Ralph Dowdell, University of Minnesota; J. C. Irwin, Thexton Mfg. Co.; W. E. Johnston, Mahr Mfg. Co.; C. S. Moody, Minneapolis Steel & Machinery Co.; N. H. Plouff, Emerson-Brantingham Co.

LEHIGH VALLEY CHAPTER

The June meeting of the chapter was held in the Battery Building of the Bethlehem Steel Co.'s plant, on Monday, June 6. The honor guest of the evening was J. E. Howard, engineer physicist of the Interstate Commerce Commission, Bureau of Safety. Mr. Howard presented a paper on the "Relations Between the Physical Properties of Steel and Their Endurance of Service Stresses". About 100 attended this meeting and thoroughly enjoyed the discussion.

BALTIMORE CHAPTER

D. K. Bullens, well known author and consulting metallurgist of Philadelphia, was the principal speaker at the meeting of the Baltimore chapter on May 24. Mr. Bullens presented an interesting discussion on the "Problems of Heat Treating" and the meeting was enjoyed by those present. The annual election of officers resulted in the following selection: Chairman, A. S. Coulter, metallurgist, Crown Cork & Seal Co.; vice chairman, S. W. Morrow, vice president, Reuse Bros. Co.; secretary-treasurer, W. E. Lehr, manager, Mergenthaler Co.; members of the executive committee, Marshall Medwedeff, H. C. Finck, A. H. Warth, H. A. Reitz, A. E. Nissen; chairman of Membership Committee, Harry C. Finck; chairman of Program Committee, A. S. Coulter.

CHARLESTON CHAPTER

About 75 members of the Charleston chapter met in the Kanawha Hotel on June 15 and listened to A. M. Redding, of the Leeds & Northrup Co., who gave an interesting paper on "Pyrometry". Considerable discussion followed the presentation of the paper, and Mr. Redding proved

very accommodating in answering the questions asked relative to this important subject.

WORCESTER CHAPTER

The June meeting of the Worcester chapter was held on June 16 in the building of the National Metal Trades Association, when a very interesting and instructive paper dealing with "The Tool Steel Industry" was presented by Roy C. McKenna, president of the Vanadium Alloy Steel Co. Mr. McKenna is an interesting and entertaining speaker, and handled his subject in a very capable manner, due to his broad experience and valuable research work in the tool steel industry.

PROVIDENCE CHAPTER

At the last meeting of the Providence chapter the following officers were elected for the coming year: Chairman, Arthur H. Annan, superintendent of the Rhode Island Tool Co.; vice chairman, R. S. Staples, metallurgist of the Taft Pierce Mfg. Co.; secretary-treasurer, William H. Hunt, purchasing agent of the Nicholson File Company.

SPRINGFIELD CHAPTER

The Springfield section held its June meeting on the 17th at the Chamber of Commerce rooms. There was no special speaker; the meeting was conducted entirely by the members and their friends, with the object of getting together to become better acquainted with one another, and to discuss problems arising from day to day in the hardening room.

In order to start discussion, Major Bellis, F. J. Evans, of the Surface Combustion Co., E. A. Sanford, metallurgist of the Hendee Mfg. Co., and F. E. Striker, metallurgist of Stevens-Duryea Co., were asked to give short talks. Those in attendance voted the meeting as one of the most interesting ever held.

MILWAUKEE CHAPTER

A very profitable and interesting meeting was held in the Medford Hotel on May 26 when Lt. Col. A. E. White, National President of the Society, made his annual visit of inspection to the chapter. The election of officers was held for the ensuing year, which resulted in the following selection: Chairman, Wells K. Gregg, metallurgist of the Kinite Co.; vice chairman, C. B. Langstroth, metallurgist of the A. O. Smith Corp.; secretary-treasurer, Fred G. Allison, chemist of the George H. Smith Steel Castings Co.

GARY CHAPTER

The June meeting of the Gary chapter was held in the Main office building of the Illinois Steel Co. at Gary on June 21. The talk of the evening was by Henry Brewer, Chicago manager of the Leeds & Northrup Co., and was an illustrated lecture upon the "Hump Method of Heat Treating Tools". The lecture proved especially interesting and was very much enjoyed by those present.

NEW MEMBERS' ADDRESSES OF THE AMERICAN SOCIETY FOR STEEL TREATING

EXPLANATION OF ABBREVIATIONS. M represents Member; A represents Associate Member; S represents Sustaining Member; J. represents Junior Member, and Sb represents Subscribing Member. The figure following the letter shows the month in which the membership became effective.

ABBE, Earl C. (M-6), Moore Drop Forging Co., Springfield, Mass.

BARNES, Charles (M-3), 2009 S. 23rd St., Philadelphia, Pa.

BARDWELL, J. P. (M-5), E. T. Ward's Sons, 260 West Street, New York City.

BATE, H. A. (M-4), 36 Grant St., Munhall, Pa.

BEATTY, Isaac N. (M-5), 407 Evans Bldg., Washington, D. C.
BUELL, William C. (A-5), C/O Geo. J. Hagan Co., Pittsburgh, Pa.
CHEETHAM, C. S. (M-5), 1142 Kentucky Ave., Indianapolis, Ind.
DANIELS, Clarence W. (M-6), 5 Montvale Road, Worcester, Mass.
EDELIN, J. W. (M-5), 407 Evans Bldg., Washington, D. C.
EGAN, Grover (M-6), H. H. Franklin Mfg. Co., Syracuse, N. Y.
GRINNELL, A. L. (S-6), 505 Garrick Theater Bldg., Detroit, Mich.
HIGGINS, John W. (M-1), Worcester Pressed Steel Co., Worcester, Mass.
HOPF, Harry W. (M-4), 532 E. 124th St., Cleveland, Ohio.
IRON AND STEEL INSTITUTE, 28 Victoria St., London, S. W. 1, England.
LEWIS, M. M. (M-6), Pacific Block & Forging Co., 224 Spear St., San Francisco, Cal.
LOVEJOY, C. E. (M-5), Case Hardening Service Co., 2281 Scranton Rd., Cleveland, Ohio.
MATTESON, J. R. (M-3), 2449 South 20th St., Philadelphia, Pa.
MATHEWS, Frank R. (M-6), 14 Princeton St., Springfield, Mass.
McCONNELL, R. Hudson (M-5), Ford Motor Co., Rouge Plant, Dearborn, Mich.
MOORE, Harry C. (M-6), 25 Hall Street, West Haven, Conn.
MOWERY, John N. (M-1), Worcester Pressed Steel Co., Worcester, Mass.
MALMQUIST, C. Wm. (M-6), Shelton Tool & Machine Co., Derby, Conn.
NELSON, Holland T. (M-5), Henry Disston & Sons, Tacony, Philadelphia, Pa.
NETHAWAY, Frank R. (M-5), 4845 Concord, Detroit, Mich.
NOBS, F. W. (M-4), Empire Mines, Grass Valley, Cal.
NYLUND, Harry E. (M-3), 2426 South 15th St., Philadelphia, Pa.
OTEY, N. S. (M-3), 1417 Ritner St., Philadelphia, Pa.
PRAY, Alfred R. (M-5), 1725 E. 70th St., Cleveland, Ohio.
REIS, James W. Jr., (M-12), Y. M. C. A., Gary, Ind.
ROGERS, Robert W. (M-5), 5 Rueckert Ave., Baltimore, Md.
SCHRAMN, Edward P. (M-4), 4863 Spokane, Detroit, Mich.
SCRIMGEOUR, C. Bailey (S-5), Cyclops Steel Co., 410 Albee Bldg., Washington, D. C.
SEREINSKY, Louis R. (M-3), Standard Brands Tool Steel Co., P. O. Box 413, Indianapolis, Ind.
SMITH, Alex H. (M-5), Crucible Steel Co. of Amer., Park Wks., Pittsburgh, Pa.
SMITH, DuRay Jr. (M-5), 263 Highland Ave., New Kensington, Pa.
SPITTLE, J. E. (M-5), 474 Maloney Ave., Dearborn, Mich.
TAYLOR, C. W. (M-5), 414 7th St. S. E., Washington, D. C.
VAN DYKE, Fred J. (M-5), 3470 Gibson, Detroit, Mich.
WEIGEL, Charles (M-3), Forge Shop, U. S. Navy Yard, Washington, D. C.
WILLETT, John A. (M-4), 5308 Larchmont, Detroit, Mich.
ZETZER, Henry (M-4), 2872 E. 112th St., Cleveland, Ohio.

CHANGES OF ADDRESS

BANGSER, Wm.—from Bancroft Razor Co., Worcester, Mass. to 393 West End St., New York City.
BELLIS, Maj. A. E. (M-11),—from 95 Princeton St., Springfield, Mass. to Bellis Heat Treating Co., Blake & Valley Sts., New Haven, Conn.
BROWN, G. Graham—from Timken Detroit Axle Co., Detroit, Mich. to Hinsdale, N. Y.
CAMPBELL, Chester M.—from 435 Chicago St., to 5052 Grove St., Elgin, Ill.
DAVENPORT, F. E. (M-9),—from 5634 Magnolia Ave., to 4204 Greenview Ave., Chicago, Ill.
DREWES, Chas. H.—from 962 Fourth St., to 823 First St., Milwaukee, Wis.

ELLIS, Shirley G.—from Atlas Crucible Steel Co., 115 Broadway, to 366 Madison Ave., New York City.

GIBSON, L. H. (M-1),—from 3 Fordham St., Jamaica Plain, Mass., to 7 Crestwood Park, Grove Hall, Mass.

GIERYMSKI, Stanley F. (M-11),—from 220 E. Main St., to 322 Washington St., New Britain, Conn.

GOODRICH, M. L. (M-11),—from Massaoit Hotel, Springfield, Mass. to Box 1262, Springfield, Mass.

HORTON, C. T. (J-1),—from 934 E. 76th St., to 13704 Othello Ave., Cleveland, O.

HUNTER, George C.—from P. O. Box 537, New Haven, Conn. to Hotel Huron, Cleveland, O.

HURLEY, Wm. B.—from Willis Ave., to 2935 W. Blvd., Detroit, Mich.

KOTTNAUER, Edward H.—from 1054 Book Bldg., to 1723 Lafayette Blvd., Detroit, Mich.

LARNED, Lieut. Elmer—from 6243 Woodlawn Ave., to 6341 Kimbark Ave., Chicago, Ill.

MILLER, Frederick (M-12),—from 50 Grove St., to 488 Colorado Ave., Bridgeport, Conn.

NASH, E. R.—from 222 Keith St., to E. County Road, P. O. Box 674, Hanford, Cal.

NEEDHAM, L. P.—from 6157 Grand Vista Ave., Pleasant Ridge, Cincinnati, O. to 5 N La Salle St., Chicago, Ill.

NIGHTINGALE, G. V.—from 163 W. Washington St., to Box 262, Chicago, Ill.

OLCOTT, Frank—from 125 Smalley St., to 53 Cottage Place, New Britain, Conn.

PELOT, J. H. (M-3),—from 10 West Church St., Bethlehem, Pa. to Picatiuny Arsenal, Dover, N. J.

PENNEY, Rupert L.—from Winchester Repeating Arms Co., to 54 West Rock Ave., New Haven, Conn.

PUTNAM, Willis S.—from 306 S. Orchard St., Urbana, Ill. to New Salem, Mass.

RING, Chas. N.—from Ohio Steel Fdry. Co., 531 Marion St. to 1020 Brice Ave., Lima, Ohio.

ROOT, H. H.—from 251 Massachusetts Ave., Arlington 74, Mass. to 83 Barnard Ave., Watertown, Mass.

SAUER, Louis J.—from 407 S. Aberdeen St. to 437 N. Racine, Chicago, Ill.

SICARD, Andrew J.—from Ingersoll Rand Co., Athens, Pa. to Sicard Tool Co., 117 Lawrence St., Hackensack, N. J.

SOWDER, Stanley—from American Twist Drill Co., Davenport St. to 6545 2nd St., Detroit, Mich.

SQUIRE, Thos. S.—from 144 Lascellus St., to 911 Walnut Ave., Syracuse, N. Y.

SQUIRES, John—from 518 Yorkshire Highway, Grosse Pointe Park, Detroit, Mich. to 4389 E. Choulear Ave., St. Louis, Mo.

WELCH, S. N.—from 23 Sabin St., Providence, R. I. to Victor Ring Tractor Co., Providence, R. I.

WILKINS, W. A. (M-2),—from 2309 32nd Ave. S. Minneapolis, Minn. to 300 10th Ave. S. Minneapolis, Minn.

WRIGHT, H. C.—from Eastonia Apts. to 1849 Ferry, Easton, Pa.

MAIL RETURNED

GUTHRIE, Robt. G. (M-10), care Whidney Co., 320 S. Jefferson St., Chicago, Ill.

HERRICK, R. L., Baumer Film Co., 6 N. 48th St., New York City.

McFARLAN, J. T., care Standard Parts Co., E. 65th & Central, Cleveland, O.

McINTYRE, F. J., Bay City, Mich.

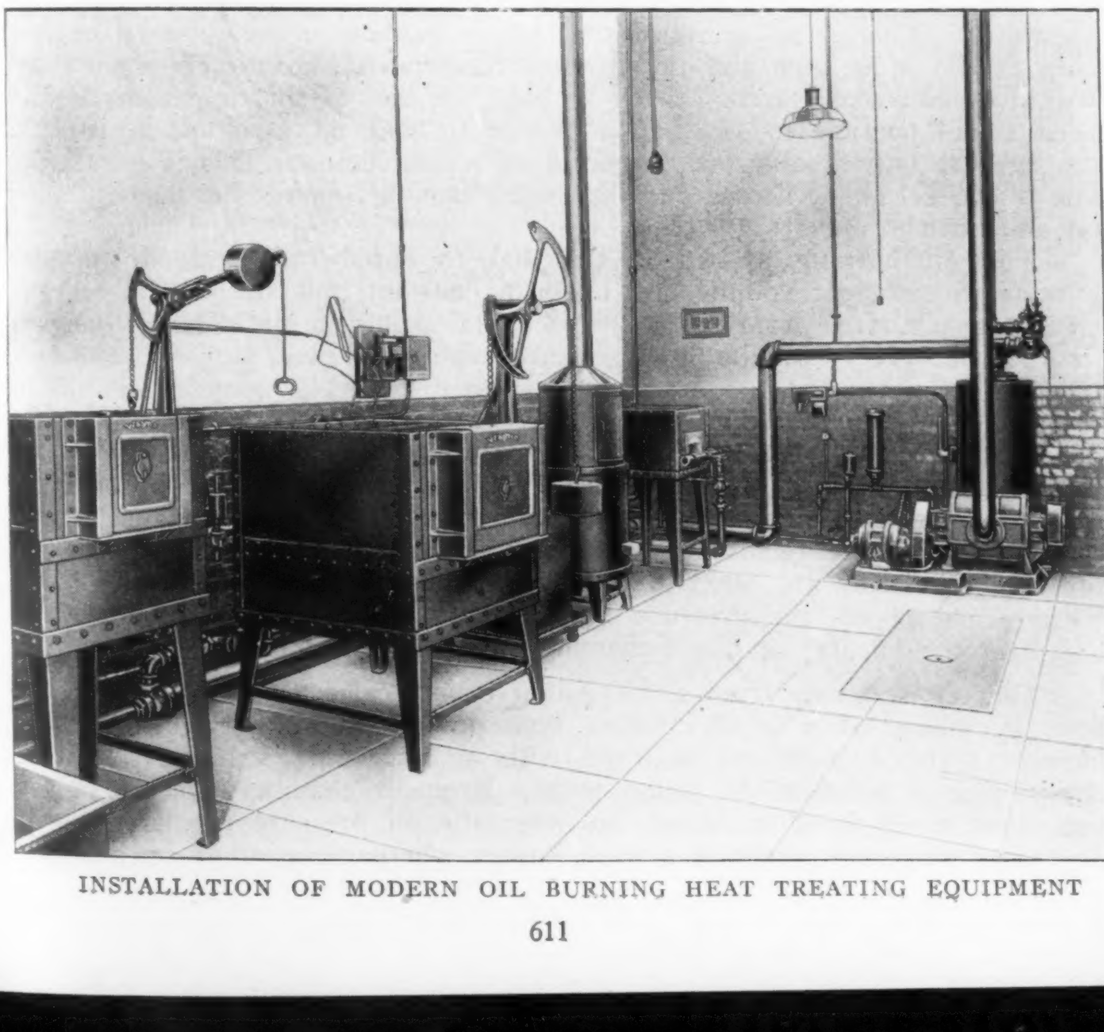
Commercial Items of Interest

EFFICIENT TOOL ROOM OIL BURNING FURNACE INSTALLATION

A large midwestern manufacturer of tanks, pumps, and similar equipment recently has equipped its tool hardening room with a complete oil burning system which is producing very satisfactory results. As this installation is modern in every respect, a brief description is of general interest. The equipment, as shown in the accompanying illustration is installed in a well ventilated room adjacent to the tool department of the plant.

At the extreme left is shown the furnace used for high speed steel work. It is of the semimuffle or oven underfired type. Next in line is a medium sized underfired oven furnace used for case hardening and annealing. The third furnace is a circular cyanide pot furnace used for case hardening small rolls, etc. At the end is a small overfired forge type furnace for tool dressing, etc.

All of these furnaces are constructed of heavy plate steel reinforced with angle irons and bands. In this way the expansion and contraction of the lining does not crack or warp the shell. The linings, with the exception of a few special tile on the smaller sizes, are all constructed of standard fire brick of the best quality. Between the lining and shell a thick layer of insulating cement is used which reduces heat radiation to the minimum.



INSTALLATION OF MODERN OIL BURNING HEAT TREATING EQUIPMENT

The doors are lined with a special cement which is much lighter than fire clay, has greater heat resisting qualities and is more durable. The cyanide pot furnace is fitted with a cast steel pot of a special analysis. This pot seems to give greater life than either the cast iron or pressed steel pots.

Each furnace is fitted with a combination gas and oil burner. In fact, before this installation was made electricity, gas and fuel oil were all considered. Electricity was found to be a very desirable fuel but the cost was much greater than the other fuels and, therefore, would not afford the saving necessary to pay interest on the large investment involved.

Under actual test, 4½ gallons of oil proved to be equal in work produced to 1000 cubic feet of 580 B.t.u. gas. This figured at the rate of 25c for oil as compared to 75c to $1.35 for gas. Therefore, fuel oil is used entirely to fire these furnaces. After making the installation, oil also proved to be just as satisfactory and as easy and clean a fuel to handle as gas, there being no smoke, the fires clean, and temperatures easily and accurately regulated. A very viscous and heavy oil of about 23 degrees Baume is used without heating but even the very small burner on the cyanide pot furnace operated perfectly when burning less than ½ gallon of oil per hour.

The burners are of the open flame type so that practically 40 per cent of the air necessary for combustion is drawn in by induction around the burners, thereby greatly reducing the power required for the blower. These burners are adjustable so that the volume of air may be reduced without reducing the pressure necessary to properly atomize the oil.

The carbonizing furnace is fitted with an automatic temperature control apparatus. This is so arranged that either gas or oil may be burned or both at the same time and the furnace temperatures accurately maintained within certain fixed limits. Even without the use of this apparatus it has been found possible to set the oil burner so that no variation in furnace temperature is noticeable over a period of several hours. This is principally due to the design of the oil burning system which supplies the burners with oil and air.

The oil burning system is designed to supply oil and air to the burners in sufficient volume and under a constant and automatically regulated pressure, free from pulsations; all vital points in the efficient burning of fuel oil. It is of the low pressure type, oil being supplied under a pressure of 5 pounds and air under a pressure of 1½ pounds per square inch.

Clean, fresh air is drawn from out of doors by means of a rotary type blower and discharged into an air receiver and thence goes to the burners. This air receiver is designed with inner and outer tubes so that all pulsations in the air are removed. A mercury pressure gauge and automatic air pressure regulators are fitted to the air receiver so that when one or more burners are closed, the pressure remains constant and it is not necessary to adjust the burners on the remaining furnaces still running.

The oil is drawn from a 550-gallon cylindrical tank buried under the floor by means of a small impeller type pump and discharged to the oil burners. The suction line is fitted with an accessible strainer. The discharge pipe is fitted at the pump with a large air chamber which removes pulsations from the flow of oil, an automatic oil pressure regulator which maintains a constant pressure at each burner whether one or all burners are

in operation, and an oil pressure gauge. At this point a by-pass valve is installed so that all of the oil in the pipe lines may be quickly drained back to the storage tank when desired.

The oil pump is driven by means of chain and sprocket wheels from the shaft of the blower which in turn is driven by means of a direct-geared electric motor on the same bedplate. Co-ordinating the oil and air supply in this way prevents danger of discharging unatomized oil into a hot furnace. A tank gallonage indicator is placed on the wall of the room and shows at a glance the contents of the tank.

Oil is purchased in barrels and the tank is filled through a flush floor waterproof box by means of a special combination skid and barrel drainer. A steel plate is placed in the floor directly over all pipe connections to the tank. Mounted on the wall is a direction board. The air pipes are painted black, oil red, gas green and electric conduit orange. The furnaces, burners, oil burning system, storage tank and quenching tanks were all designed, manufactured and installed in its own plant by the Wayne Oil Tank Pump Co. Fort Wayne, Ind.

The Brown Instrument Co., Philadelphia, manufacturer of instruments for indicating and recording temperatures, pressures, speeds, operations, and drafts, has opened a branch office in Cleveland, at 201 Reliance Bank building, 1634 Euclid avenue. The company now has a total of eleven district offices, located in New York, Pittsburgh, Detroit, Cleveland, Chicago, St. Louis, Denver, Los Angeles, San Francisco and Montreal.

The made-in-Indianapolis industrial exposition the week of Oct. 10 is now assured following the pledging of nearly 100 manufacturers, among whom the trade was prominently represented, to display their products at a meeting recently at the Chamber of Commerce.

H. B. Wilson has taken charge of the Mahr Mfg. Co.'s branch office at 915 Olive street, St. Louis. The company, which manufactures oil burning equipment, maintains its headquarters in Minneapolis.

Electric heat treating and annealing furnaces are described and illustrated in a 16-page illustrated booklet being circulated by Holcroft & Co., Detroit. The furnaces are designed to operate from standard power circuits and are designed along lines of standard construction. The information given in the booklet is interesting and valuable to those whose problems of manufacture include that of heat treating and annealing of either ferrous or nonferrous metals.

F. J. Ryan & Co., Franklin Trust building, Philadelphia, have announced that it recently was awarded a contract for the furnace and burner equipment to be installed at the new plant of the Philadelphia Spring Co. The Philadelphia Spring Co. will manufacture high grade springs for cars, specializing in this work.

Preliminary arrangements for the already existing local sections of national engineering societies in the District of Columbia to merge into a single body were completed by representatives of organizations at a dinner meeting of the Washington chapter of the American Society of

EMPLOYMENT SERVICE BUREAU

The employment service bureau is for all members of the Society. If you wish a position, your want ad will be printed at a charge of 50c each insertion in two issues of the Transactions.

This service is also for employers, whether you are members of the Society or not. If you will notify this department of the position you have open, your ad will be published at 50c per insertion in two issues of the Transactions. Fee must accompany copy.

Important Notice.

In addressing answers to advertisements on these pages, a stamped envelop containing your letter should be sent to AMERICAN SOCIETY FOR STEEL TREATING, 4600 Prospect Ave., Cleveland, O. It will be forwarded to the proper destination. It is necessary that letters should contain stamps for forwarding.

POSITIONS WANTED

WANTED—Position as assistant hardener. Practical experienced man in case hardening and heat treating of all different makes of steel. Do not claim to be an expert but can deliver the goods. Salary $25.00—$30.00 per week. Address 2-8

WANTED—Position as metallurgical engineer in technical, executive or sales capacity. Ten years practical experience in research, physical and chemical testing, pyrometry, metallography, inspection, and specifications. Have installed heat treating plants and laboratories. Address 2-5

WANTED—Position as metallurgist or assistant, graduate of University of Minn., one and one half years with large tractor company, covering heat treating, chemical, metallographic and physical testing, during that period. Chicago territory preferred. Salary $175.00 a month. Address 2-6.

WANTED—Position as salesman. Graduate of Carnegie Technical Institute. Student for 16 months with large steel company, Three years selling, Best of references. No preference as to location. Address 2-7

GENERAL SUPERINTENDENT OR PRODUCTION MANAGER—8 years as general superintendent with large manufacturing firm. Expert on manufacturing firm arms and munitions, machinery and small interchangeable parts. Eastern location preferred. Address 4-1.

CHEMIST OR METALLURGIST—6 years as chemist and three years as chief chemist and assistant to the metallurgist. Cleveland location preferred Address 4-2.

SALESMAN—Selling steel or metallurgical supplies. Knowledge of Spanish, Willing to travel. Have been chief metallurgist for large Eastern firm. 7 years experience in heat treating of carbon, alloy and high speed tool steel, and general production work. Experienced in metallography, physical testing, pyrometry, and analysis. Best of references. Address 4-3.

SALESMAN—Have had 6 years in chemical and physical laboratories of tool steel concerns. 3 years in charge of heat treating tool steels. No preference as to location. Wages $175.00 a month. Address 4-4.

FOREMAN OR ASSISTANT FOREMAN—Practical, experienced in all around forging, blacksmithing and treating of steel. Experienced with tools used in shipyards and machine shops. Prefer location in Chester, Pa., Camden, N. J., or Philadelphia, Pa. Address 4-5.

METALLURGIST OR ASSISTANT METALLURGIST—College graduate. At present assistant metallurgist in large motor car company. Capable of handling heat treating, microscopic work, chemical analysis, and pyrometry. Desire Central or Wester location. Salary $250.00 per month. Address 4-6.

METALLURGICAL ENGINEER—Young, capable energetic, with 11 years experience. Graduate engineer. Bureau of Standards for 7½ years. Erie Forge Co. for 3 years. Expert in pyrometry in steel plant, forge shop, open hearth and heat treating plants, metallurgy, investigations and research, planning metallurgical operations, heat treating carbon or alloy steels, and management, forge shop temperature scheduling, etc. Salary desired $3000, or make your proposition. Answer 7-2.

METALLURGIST—Age 25, experienced in manufacture of steel from blast furnace to the finished, heat treated and tested product. Desire to form a connection with company now building up an organization where opportunity at present as the future shall predominate. Cleveland district preferred. Answer 7-3

Superintendent of heat treating—Have had 12 years' experience as blacksmith and in heat treating. At present in charge of same in large automobile plant. Have installed equipment, and have some experience along mechanical lines. During war in charge of aircraft forging, heat treating and as metallurgist. Salary desired $3600. Answer 7-1.

Mechanical Engineers at the New Ebbitt hotel, in that city, June 9. The plan is to build an organization around an existing engineering society and will probably include the scientific and engineering associations.

On June 29, Sir Robert Hadfield was presented with the John Fritz medal for his meritorious work in inventing manganese steel. The presentation took place in London at the opening meeting of the British Institute of Civil Engineers. Several representatives of American engineering societies made the trip to England to attend the meeting.

A rotary electric furnace having a connected load of 270 kilowatts was installed recently in the plant of the Nash Motors Co., Milwaukee, by the George J. Hagan Co., Pittsburgh. The furnace will be used for heat treating and annealing automobile parts.

A machine for pressing plastic carburizing compound about ring gears has been developed by the Hanna Engineering Works, Chicago. The work is placed on the platen and the compound is spread on the teeth. After the die is placed on top, a foot treadle is operated which causes packing of the compound.

The General Alloys Co. announces the opening of a branch office at 921 Granite Building, Rochester, N. Y., under the direction of Ralph C. Schwarz. Mr. Schwarz is a mechanical engineer with a wide experience in heat treating problems and has a large established clientele in western New York. H. H. Harris, president of the General Alloys Co., was to leave New York about June 10 on a motor trip to the various eastern branches of the company accompanied by one of the company's metallurgists. Mr. Harris will inspect the company's installations throughout this territory.

"Heat Treatment of Soft and Medium Steel", is the title of a new book written by Frederico Giolitti and translated by E. E. Thum and D. G. Vernaci and published by the McGraw-Hill Book Co., New York. The *Iron Trade Review* says regarding the new book: "The author, who discusses the theory and practice of the preliminary heat treatments designed to give maximum toughness to steels used for machine parts, contributes another volume to the limited literature on the subject of heat treating. It is claimed to be the first treatise dealing with the effect of various impurities and addition agents on commercial heat treatment and should prove a powerful stimulus to their study. Dr. Giolitti points out the tremendous advantages to be gained by the elimination or suppression of these impurities and addition agents.

"Special attention has been given to the so-called "flakes" and "woody fractures," a disease of metals well understood and under control in the Italian works managed by the author. This portion of the text should be particularly important to many consumers and producers who ultimately will be dealing in steel castings of high strength and toughness, such as have been under tonnage production for several years. Dr. Giolitti's volume should be of great usfulness for its insistence that commercial heat treatment of steel depends primarily upon the diffusion of carbon and other soluble substances contained, gaseous or solid. In turn the

(*Continued on page* 38)

This request for workers will be printed in the Position Open section of the Employment Bureau of the Transactions at a cost of 50c each insertion. The money to cover this charge should accompany this form.

EMPLOYER'S REQUEST FOR WORKERS

Name of Employer

Address

Kind of Work

Experience and educational requirements:

Wages

Apply To

If you need men, fill out this blank and send to American Society for Steel Treating, 4600 Prospect Avenue, Cleveland, Ohio.

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and
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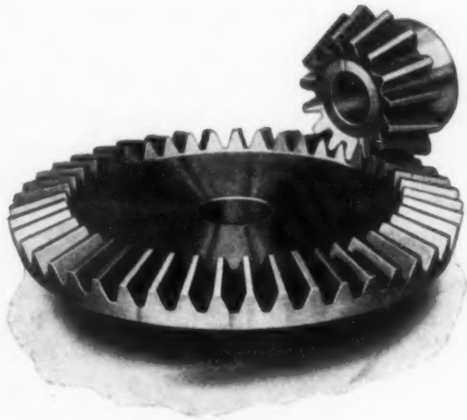
GEARS



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Rawhide
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CHICAGO ILLINOIS

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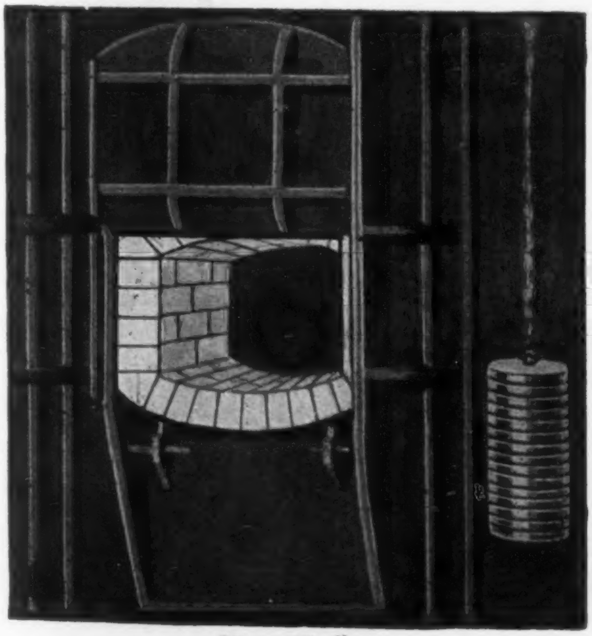

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Canadian Representatives:
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Montreal, Quebec.

(*Continued from page* 35)

approach to equilibrium is affected materially by the speed of cooling, the spacing of centers of crystallization, the content of insoluble nonmetallic inclusions and their physical and chemical constitution, the temperature of transformation and the thermal hysteresis. The book is divided into five parts as follows: Part I, Phenomena of Diffusion in Primary Solid Solution; Part II, Effects of Diffusion Upon Secondary Crystallization; Part III, Diffusion in Austenite as Applied to the Preliminary Heat Treatment of Steels; Part IV, Preliminary Heat Treatment of Steel Castings; Part V, Preliminary Heat Treatment of Forged and Rolled Steels."

According to an announcement made by the American Foundrymen's Association, the next convention and exhibition will be held in April or May, 1922. Originally the meeting was scheduled for the fall of this year, however when the committee on conventions and exhibits met in March, it was found that in none of the eight cities considered was it possible to find during September or October adequate hotel accommodations and exhibition facilities to care for such meetings properly. Therefore the board of directors decided to postpone the meeting until next spring and again to follow the custom which existed prior to 1912.

At a joint meeting of the Cleveland Engineering Society and the engineering section of the National Safety Council, C. P. Tolman, chief engineer and chairman manufacturing committee, National Lead Co. and

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(*Continued from page* 38)

president of the National Safety Council, presented an address entitled "Engineering Revision—The Engineers Part in Safety". Mr. Tolman pointed out that the best insurance against accidents was the safeguarding of all machinery and equipment which was dangerous to workmen. A number of examples and means of protection were cited.

The Hoosier Rolling Mill Co., Terre Haute Ind., recently has completed a new plant 80 x 400 feet which will be devoted to the manufacture of automobile and truck springs. It is expected that operations will be started at an early date.

The secretary of the American Engineering Standards Committee, Dr. P. G. Agnew, has just returned from a short trip to Europe where he attended a conference in London of the secretaries of the national standardizing bodies. After the conference he visited France, Switzerland, and Germany for a more detailed study of the standardization work in those countries. The conference had for its object an interchange of experience and the furtherance of co-operation between the various national bodies in their work of industrial and engineering standardization

Notwithstanding great differences in the details of procedure, the same general method of work is followed in the different countries, namely, technical decisions concerning any specific piece of work are in the hands of a working committee which is so constituted as to be broadly representative, from both the technical and the managerial points of view,

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(*Continued from page* 41)

of the particular branch of the national industry concerned. This same general method is followed whether the work is of the nature of specifications, methods of test, or dimensional standardization.

It was the view of the conference that international co-operation in industrial standardization work should proceed along such informal lines being based primarily upon the interchange of information on active subjects of mutual interest, rather than by any attempt at the present time to form a general international standardizing body; that in cases in which formal organization should be found necessary, the organization should preferably be by subject or industry, somewhat along the lines of the International Electrotechnical Commission; but that in all cases efforts should first be made to secure results by less formal methods; and to this end it would often be desirable that in a given subject, the office of one of the national bodies most interested should, by informal agreement, perform such secretarial functions as would further international agreement in the particular subject.

The Electrical Refractories Co. with factories at East Palestine, O., is making enlargements to its plant so that it will be able to supply the increased demand for products. For some time past, the company has supplied heating element support to many of the large manufacturers of electrical supplies in the country, and this firm has been supplying about 90 per cent of the electric range companies in the country and in Canada. This heating element support is made from an A-1 formula which is

(*Concluded on page* 45)

(*Concluded from page 42*)

also used in laboratory stoves, water and immersion heaters, etc. Its formula B-2 is used in resistance type annealing ovens and steel heat treating furnaces. The fusing point of A-1 is about 2600 degrees Fahr., and of B-2 about 3000 degrees Fahr. Steel dies are used in the production of the company's refractories and are constructed according to the specifications of customers.

The Franklin Institute of the State of Pennsylvania, acting through its committee on science and the arts, investigating the jet entraining apparatus of The Surface Combustion Co., industrial furnace engineers and manufacturers, have awarded to the inventor, W. Barton Eddison, the Edward Longstreth medal of merit.

A semi-technical publication known as the *Box Bulletin,* is being published by the General Alloys Co., and began with the June issue. This publication contains less than 25 per cent of advertising, the balance of the space being condensed technical articles written by men of note in the heat treating field, but having no connection with the General Alloys Company. The *Box Bulletin* is starting in a small way in condensed form but it is the hope of its publishers that its reception will warrant an increase in size. The publication will be distributed gratis to any user of heat treating metals. Those interested may be placed on the free mailing list, by writing on their letter-head to the *Box Bulletin,* Peoples Gas Building, Chicago.